INSTRUCTION MANUAL
MODEL 108
PULSE GENERATOR

DATAPULSE

MP MASTER
MA28870

INSTRUCTION MANUAL
MODEL 108
PULSE GENERATOR

Your Datapulse Model 108 Pulse Generator is an all solid state, high quality pulse generator combining functions previously unavailable in commercial pulse generators.

The instrument features clean, high power pulses, high duty cycle capability, very fast rise times and high repetition rates. Coupled with these features is the capability to generate clean, low power pulses at low repetition rates and wide pulses. The 108 has been designed to perform any pulse application conveniently and with the utmost reliability.

This instruction manual contains general and detailed instructions for operation and maintenance of your Model 108. A complete understanding of its contents will contribute greatly to full utilization of the extremely broad capabilities of this instrument.

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MODEL 108

PULSE GENERATOR

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SCHEMATICS

Drawing No.	Description
41000-024	Block Diagram - Model 108
40000-052	Schematic - Power Supply
40000-053	Schematic - Attenuator 50 db
40000-055	Schematic - Front End
40000-056	Schematic - Output Amplifier
40000-057	Schematic - Power Supply Output Amplifier

ABBREVIATION - SYMBOLS - TERMINOLOGY

WARRANTY

INSTRUMENT CERTIFICATION

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SPECIFICATIONS

1.1 REPETITION RATE

Continuously variable from 10 cps to 10 mc, covered in six decade ranges. Full scale accuracy of each range is nominally ±5% (±7% max.). Jitter is less than 0.1%.

1.2 EXTERNALLY TRIGGERING

Sync Output occurs at a fixed delay of approx. 130 nanosec. from external trigger. Unit operates at 0 to 10 mc from ±5v pulses (30 nanosec. min. duration) or at 10 cps to 10 mc from 4v rms sine waves. Polarity and sensitivity controls provide for reliable triggering at any point on the input waveform more than 5v above or below average DC level. Input impedance is approx. 5,000 ohms. Maximum signal level which may be applied with sensitivity control at max. is ±10v.

1.3 SINGLE PULSE

Operation of a front panel pushbutton provides one cycle of output.

1.4 GATED OPERATION

External gate signal levels more negative than minus 6v block main pulse output, no connection or levels more positive than minus 2v enable. Gate signal must furnish approx. 3 ma during disabling. Levels greater than ±25v may not be applied.

1.5 SYNC OUTPUT

Selectable either pos. or neg., variable from approx. 0.25v to at least 6v into 50 ohms (approx. 15v open circuit, 10v into 100 ohms). Pulse width is approx. 20 nanosec., rise time approx. 7 nanosec.

1.6 MAIN PULSE DELAY (of minimum rise time leading edge from Sync Output)

Continuously variable from 0 to 5 millisec., covered in five decade ranges. Max. delay duty cycle is greater than 50% of pulse spacing, externally or internally triggered.

1.7 MAIN PULSE DURATION (at 50% amplitude point of minimum rise time waveform)

Continuously variable from less than 20 nanosec. to 5 millisec., covered in five decade ranges. See Main Pulse Output for duty cycle limitations.

1.8 JITTER, ACCURACY, AND STABILITY (delay and duration)

Jitter is less than 0.1% plus 0.5 nanosec. Full scale accuracy of each range is nominally ±5% (±7% max.). Stability (typical change with line voltage variation of ±10%) is better than ±0.2%.

1.9 MAIN PULSE OUTPUT

Direct coupled, selectable as Positive, Off, or Negative.

1.9.1 Amplitude

Continuously variable from 0.2 to 50v into 50 ohms (0 to 50 db attenuation) covered in 2db steps plus fill-in. Steps are calibrated in volts into 50 ohms, accuracy approx. ±5%. Line voltage variations have negligible effect on pulse amplitude.

1.9.2 Base-Line DC Level

Less than 1 mv at full amplitude, reducing with attenuation, except for the effect of leading edge and trailing edge waveform aberrations at high duty cycles above 2 mc(which are typically less than 2% of pulse amplitude).

1.9.3 Source and Load Impedance

Output is a voltage source (pulse-top diode clamped) presented through a constant impedance 50 ohm attenuator, i.e., source impedance is approx. 50 ohms at amplitudes of 10v and less. Unit is designed for operation into a 50 ohm load and is overload protected against output shorts or loads less than 40 ohms.

1.9.4 Duty Cycle and Overload Protection

Max. pulse width duty cycle is 50% (except 40% max. with pulse widths greater than 2 millisec.). Automatic overload protection against excessive duty cycle, output shorts, or loads less than 40 ohms causes pulse distortion, reduces average current by disabling output for approx. two second periods, and is indicated by a panel lamp. Operation returns to normal when overload condition is corrected.

1.9.5 Back Voltages

Opposite polarity voltages in excess of approx. 500 mv are diode clamped to ground, fully protecting output transistors unless more than approx. 300 ma is provided by the back voltage source. Same polarity voltages are diode clamp limited to the pulse amplitude and are further limited by attenuator power ratings to 35v DC max. (10v DC max. at pulse amplitudes less than 16.5v).

1.9.6 Rise and Fall Time (with 50 ohm resistive load)

Less than 7 nanosec. with control at min. Rise and fall time together may be degraded by continuous control to approx. 50 nanosec. with clamped exponential waveform.

1.9.7 Waveform Aberrations (with properly connected 50 ohm resistive load)

Overshoot, undershoot, ring and top slope are typically ±2% (±4% max.) at amplitudes greater than 5v, increasing to ±7% max. at 200 mv (except at less than 500 mv with transition times less than 9 nanosec.).

1.10 POWER

105 - 125v, 50/60 cycle AC, approx. 150 W max.

1.11 OPERATING TEMPERATURE

Designed for operation at 0 to 50°C ambient.

1.12 PHYSICAL

Aluminum front panel with etch black and red markings, beige cabinet with quick-release top and bottom covers, forced air cooling with filter. 8 3/4" H x 17" W x 15 1/4" D. May be rack mounted (8 3/4" H x 19" W panel space) by specifying Model 108R or by installing Type 1002 Rack Mounting Set. Net weight is approx. 33 lbs., shipping weight approx. 45 lbs. All signal connectors are BNC type.

1.13 ACCESSORIES FURNISHED

One operation and maintenance manual, 8 ft. line cord with NEMA 3-prong plug.

1.14 ACCESSORIES AVAILABLE

4 ft. 50 ohm cable with BNC connectors (Type 4048), 50 ohm 15 watt termination (Type 2002A), rack mounting set (Type 1002), additional manual copies.

OPERATING INSTRUCTIONS

2.1 DESCRIPTION OF CONTROLS AND CONNECTORS

2.1.1 Power ON Switch

Connects or disconnects ac input voltage to transformer primaries and fan motor within the instrument. The pilot lamp above the switch lights when the power is on.

2.1.2 Repetition Rate

The black outer knob selects the repetition rate range. There are six ranges each covering one decade of frequency. One position is provided for single pulse operation and one position for external triggering with positive going waveforms and one position for triggering with negative going waveforms.

2.1.3 Repetition Rate--Vernier

The red inner knob provides continuous fill-in between ranges of the repetition rate control. With this control fully clockwise, the instrument is calibrated at the frequency shown by the repetition rate control.

2.1.4 Single Pulse--Push Button

Each depression of the button initiates one cycle of output when repetition rate control is in single pulse position.

2.1.5 Trigger Input

BNC connector which accepts a pulse or sine wave to slave oscillator to outside signal when repetition rate control is in EXT.

2.1.6 External Sensitivity

Adjusts the level on an external signal at which the oscillator triggers.

2.1.7 Sync Output

This BNC connector provides a narrow output pulse on each cycle which serves as a zero time reference for the delay circuit.

2.1.8 Sync Polarity

This switch controls the polarity of the Sync Output pulse.

2.1.9 Sync Volts into 50Ω

This control adjusts the amplitude of the sync output pulse. When the sync pulse is loaded with 50 ohms the amplitude is continuously variable from .25V to more than 6V.

2.1.10 Gate Input

This BNC connector provides an input for an external gating signal. When an applied d-c level is more negative than -6V, output pulses are disabled. Maximum input is ±25V.

2.1.11 Pulse Delay

The black outer knob selects the delay range. There are five ranges, each covering one decade.

2.1.12 Pulse Delay--Vernier

The red inner knob provides a continuous fill-in between ranges of the control. With this control fully counter clockwise the instrument is calibrated at the delay shown by the Pulse Delay control.

2.1.13 Pulse Width

The black outer knob selects the width range. There are five ranges each covering one decade.

2.1.14 Pulse Width--Vernier

The red inner knob provides continuous fill-in between ranges of the control. With this control fully counterclockwise the instrument is calibrated at the width shown by the Pulse Width control. NOTE: On very narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop, triggering the overload protect circuit.

2.1.15 Amplitude Range--Pulse Volts with 50Ω Termination

Two concentric switch dials indicate the magnitude of the output voltage when the Vernier control is in the clockwise position and the output is terminated with 50Ω.

2.1.16 Amplitude--Vernier

The black knob provides continuous fill-in between ranges of the Amplitude Range control. When this control is in the fully clockwise position the instrument is calibrated at the setting of the Range control.

2.1.17 Pulse Polarity--NEG--OFF--POS

This switch allows the output pulse to be either Positive, Off or Negative.

2.1.18 Rise Time

This control decreases the Rise and Decay time of the Output pulse.

2.1.19 Pulse Output

This BNC connector couples the variable parameter pulse to an external load.

2.1.20 Overload

This lamp ignites when the output is terminated with low resistive loads or is short circuited. NOTE: On very narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop, triggering the overload protect circuit.

2.1.21 Fuse (located on rear panel)

2 Amp Fast blow fuse protects against a-c overload.

2.1.22 Power Input (located on rear panel)

This 3-prong recessed male connector accepts a NEMA 3-wire line cord to supply ac power from the line.

2.2 PLACING IN OPERATION

2.2.1 Preliminary Settings

a. Set REPETITION control to 0.1 mc/s, VERNIER cw.
b. Set PULSE DELAY control to .05 μs, VERNIER ccw.
c. Set PULSE WIDTH control to .05 μs, VERNIER cw.
d. Set RISE TIME control ccw.
e. Set AMPLITUDE to 20 volts, VERNIER cw.
f. Load PULSE OUTPUT with 50 ohms.
g. Set PULSE POLARITY to NEG.
h. Set POWER Switch to ON PILOT SHOULD LIGHT
i. Sync scope from SYNC OUTPUT. Set Scope Sweep Speed to 0.1 μs/cm, vertical sensitivity to 10 v/cm.
j. View pulse output, comparing it with that shown in Figure 2-1.

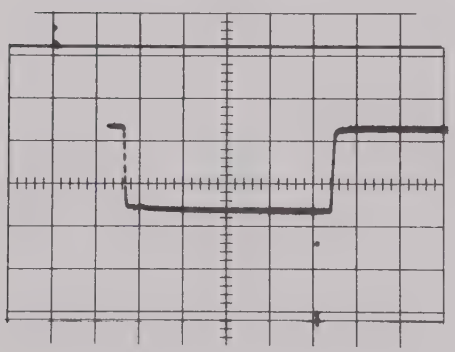


Figure 2-1. NEG Output Pulse
With 50 ohm load
0.1 μs/cm, 10V/cm

k. Switch Pulse Polarity to POS and view pulse output comparing it with that shown in Figure 2-2.

l. If instrument fails to function properly, refer to Para. 4.3.

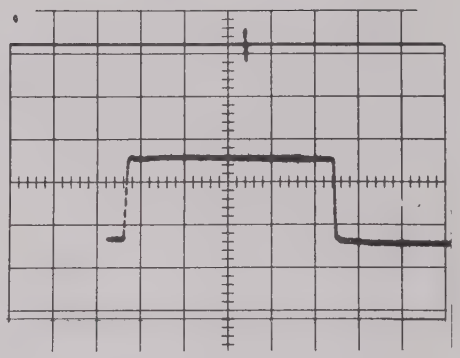


Figure 2-2. POS Output Pulse
With 50 ohm load
0.1 μs/cm, 10V/cm

2.3 OPERATING CONSIDERATIONS

2.3.1 External Triggering

When the repetition rate control is in the EXT - or EXT + position, the Model 108 can be driven from an external source provided that the driving signal is greater than 5v in amplitude and greater than 35 nanoseconds in width. As the synchronizing circuit is a Schmitt trigger with 10 cps frequency response, the slope and rise time of the driving waveform is not critical. In EXT - position the circuit will trigger on the negative going slope of the input waveform, and the EXT + position the circuit triggers on the positive going slope.

When externally driving the Model 108, always set the sensitivity control to the full counter-clockwise on minimum position before application of the driving waveform. This will insure that no damage will be done to the Schmitt trigger should the driving waveform be greater than ±10v in amplitude. With the external signal applied to the external trigger input jack and the sensitivity control in the minimum position, adjust the sensitivity clockwise until stable triggering is obtained. Do not advance the sensitivity control any more than is necessary as the lowered input impedance and attendant overdrive may cause severe distortion of the input signal which can result in unstable multiple triggering of the Model 108.

WARNING

Always insure that the driving signal is

less than ±10v when the sensitivity control is in the maximum (clockwise) position to avoid damage to the Schmitt trigger circuit.

As the input to the synchronizing circuit is ac coupled, the reference level presented will vary as a function of the duty cycle and/or amplitude at the driving waveform. Therefore, when either of these parameters is changed, the sensitivity control must be readjusted to provide triggering at the same point on the input signal.

2.3.2 Duty Cycle Limitations

Average power supply current available limits the maximum Pulse Width duty cycle of the 108 to 50%. At duty cycles in excess of 50% the power supply will go out of regulation and cause considerable pulse distortion and reduced amplitude, causing the unit to go into overload.

The Delay and Width controlling one shot multivibrators have duty cycle capabilities exceeding 70%.

In order to minimize confusion resulting from excessive duty cycle, it is recommended that the delay and width controls be set to their minimum positions when frequency is being changed, and then set to the desired settings upon completion of frequency shift. A common error is to have excessive delay duty cycle without realizing it.

CAUTION

When observing, or making any corrections to the output circuitry (including its power supply) it is necessary that the output polarity switch be on OFF or NEG. The unit may be permanently damaged otherwise.

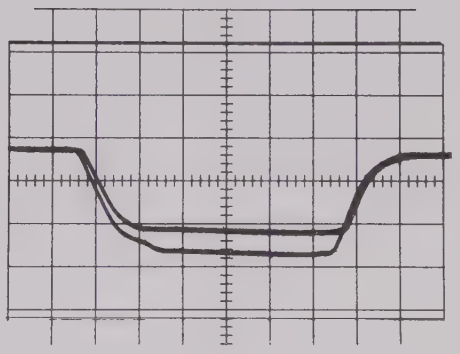
2.3.3 Rise Time Control

This control decreases the leading and trailing edge transition times to a maximum of approximately 50 nanoseconds. This slowing down of the output pulse transition times may prove very useful in minimizing the amplitude of impedance mismatch reflections when driving imperfect loads.

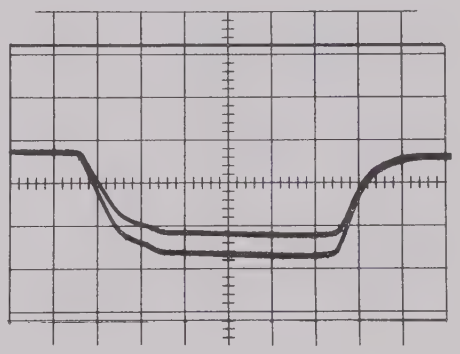
2.3.4 Output Amplitude Control

The step amplitude control is accomplished through the use of a series of constant impedance "T" pad 50 ohm attenuators, the vernier fill-in is, however, accomplished through a top clamping technique. The noticeable difference in using a small increment (2db) of step attenuation and the vernier fill-in is shown in Figure 2-3. When the rise time control is fully counterclockwise (min. rise time), waveshape differences are not apparent.

Figure 2-3



A. Output at full amplitude (50v) with vernier control at X1 and X.8 Rise time control fully clockwise (max.)



B. Output with amplitude Control at 50 and 40 volts, vernier at X1 Rise time control fully clockwise (max.)

2.3.5 Loading Considerations

One of the major advantages of the Model 108 over other pulse generators is its clean waveform at very fast rise time. In order to preserve the high degree of pulse fidelity, it is imperative that due consideration be given to proper pulse termination techniques.

Because of the wide usage of 50 ohm coaxial cables and accessories in industry, the Model 108 was designed for operation with a 50 ohm load.

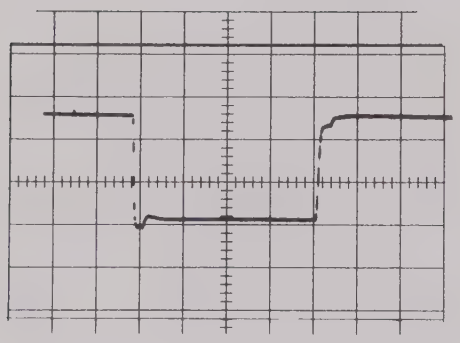
The Output Section of the 108 consists of a current amplifier which supplies approximately 5% more current than is required for 50v into 50Ω. This 5% (approx. 50 ma) is clipped off the pulse top by clamping diodes in order to give extremely flat top pulse characteristics and clean waveshape.

The pulse from the output amplifier is fed through approx. 7 feet of 50Ω coaxial cable and a 50Ω attenuator before reaching the output connector.

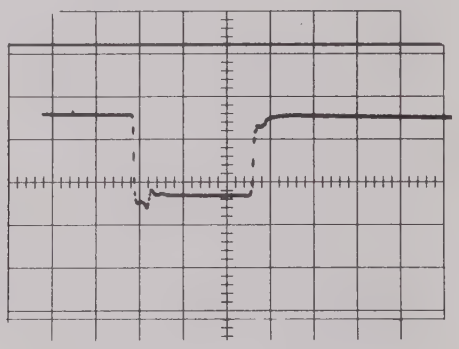
When the attenuator is set for little or no attenuation, mismatches at the output will cause pulse deformity due to lack of source termination. See Figure 2-4 for typical waveshapes due to improper termination.

Figure 2-4

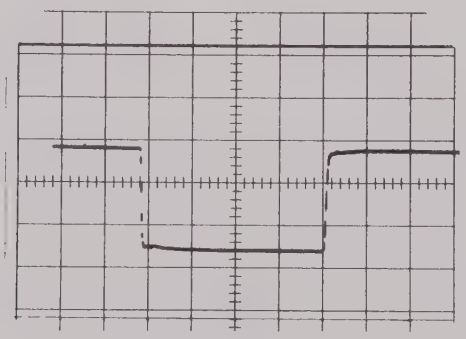
Photographed from Tektronix Type 661
Sampling Oscilloscope
100 nanosec/cm; 20V/cm



A. Full Amplitude Neg. Pulse
Loaded with 62 ohms at the Output Connector



B. Full Amplitude Neg. Pulse
Loaded with 39 ohms at the Output Connector



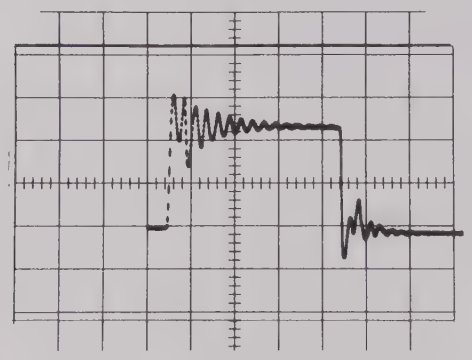
C. Full Amplitude Neg. Pulse
Loaded with 50 ohms
Note absence of Overshoot & Step at Pulse Trailing Edge

2.3.6 Cabling Considerations

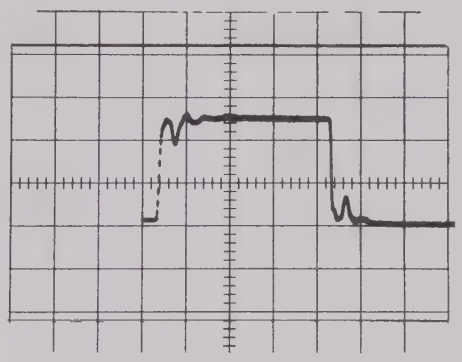
In most cases the Model 108 will be used to drive loads which are physically separated from it by several feet. In this case, it will be necessary to convey the signal by means of a 50 ohm transmission line. Preservation of low distortion waveforms is largely contingent upon the method of cabling and in proper termination of the transmission line. Clean waveforms are maintained by connecting the generator to its load with 50 ohm coaxial cable, and terminating the cable AT THE LOAD into 50 ohms. Figure 2-5 illustrates the effects of poor cabling. Figures 2-6 and 2-7 illustrate proper cabling.

Figure 2-5

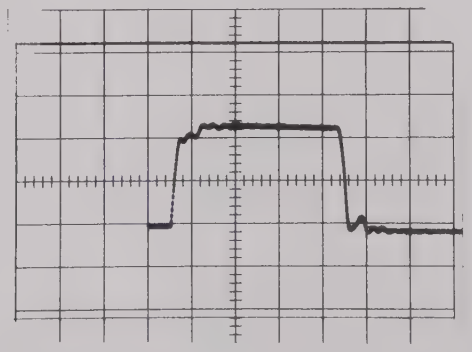
All photos were taken using a Tektronix Type 661 Sampling Scope
Vertical Sensitivity set at 20V/cm



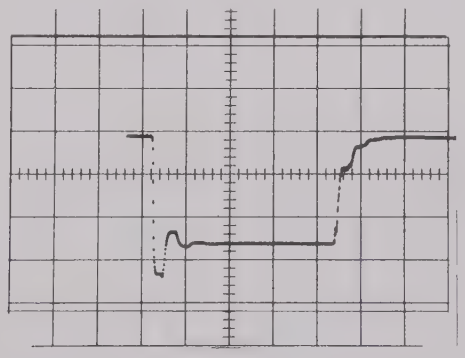
A. Pos. Output at the end of 4 ft. of RG58A/U cable terminated with 50 ohms at the generator (.1μs/cm)



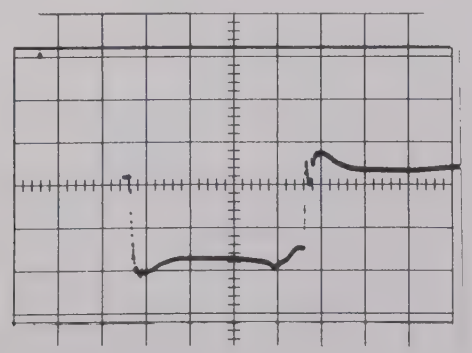
B. Pos. output at the end of 4 ft. of RG63/U(93Ω cable) terminated with 50 ohms at the scope (.1μs/cm)



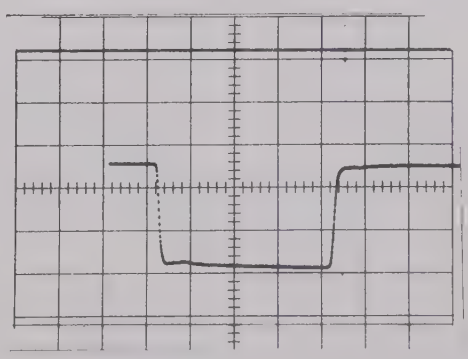
C. Positive Output under the same conditions as (A), except rise time control on generator turned cw. (.1μsec/cm)



D. Neg. Output viewed at the output jack with a 100Ω load. (reflection due to 6 to 8 ft length 50Ω coax inside the generator (.1μs/cm)



E. Neg. Output at the end of a 4 ft. clip lead, terminated with 50 ohms at scope. (.5μsec/cm)



F. Neg. Pulse through 4 ft. RG58A/U cable, terminated into 50Ω at scope. (Proper Technique)(50ns/cm)

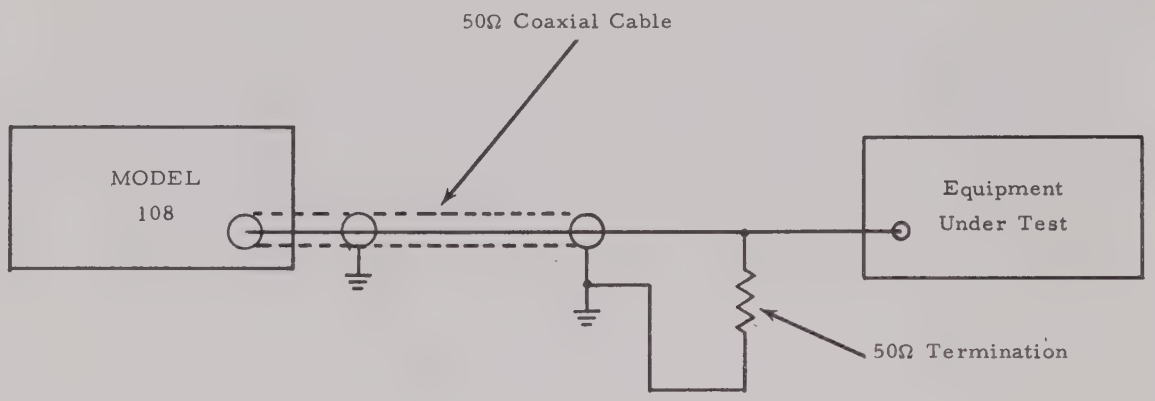


Figure 2-6. Proper Cabling Connection for Driving External Equipment.

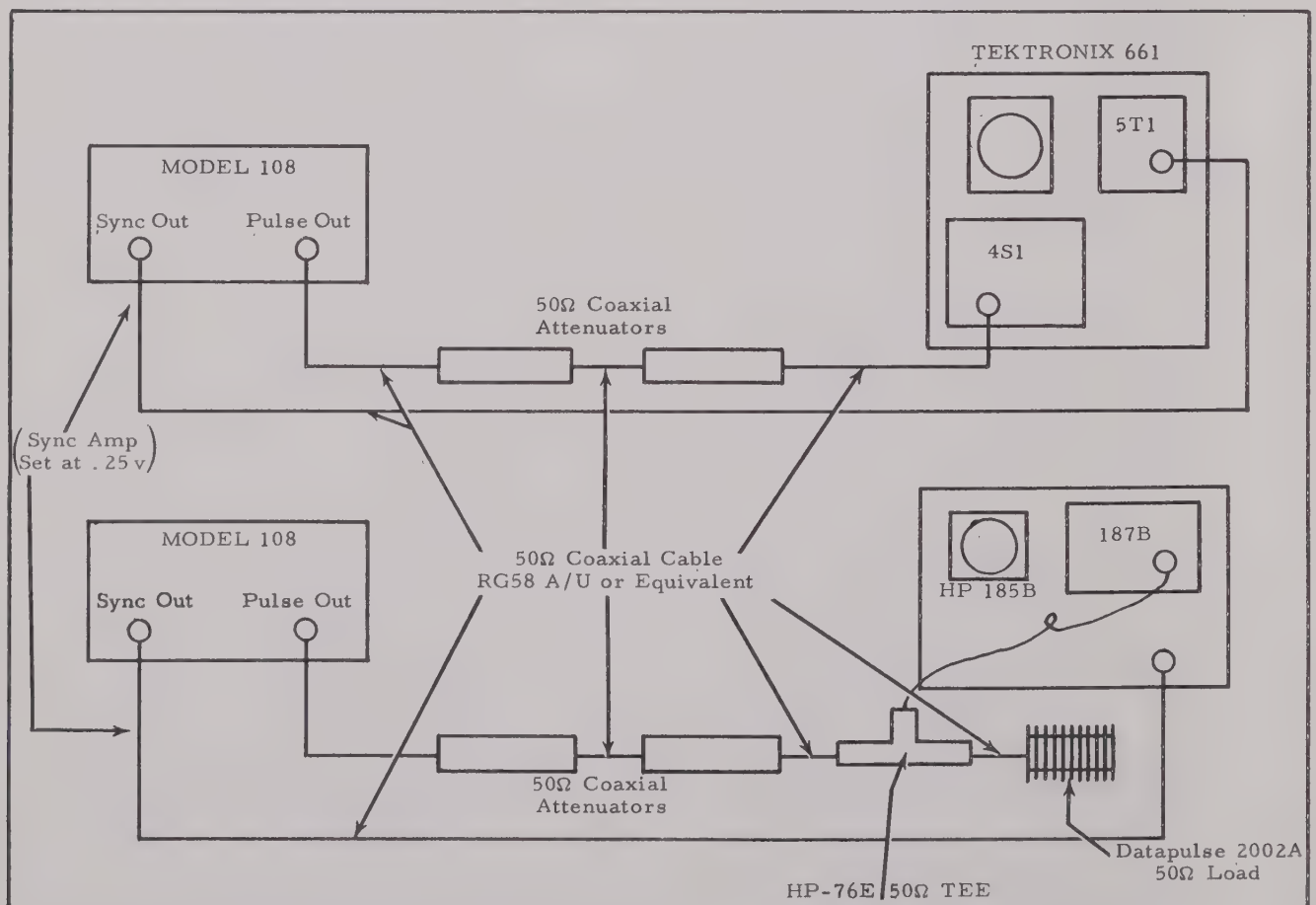


Figure 2-7. Methods of Observing Pulse Output on High Frequency Sampling Scopes

2.3.7 Mixing of Outputs of Several Model 108 Generators

As shown in Figure 2-8 the upper and lower levels of the output pulse are clamped; this indicates that without any attenuation between the output pulse and the output jack, the maximum excursion of external pulses is limited to these voltages. In other words only pulses of the same polarity may be mixed without previous pulse attenuation. Pulses of both polarities may be mixed when 10 db or more of attenuation is inserted, providing a source termination of nearly 50 ohms at the generator. Caution should be taken not to exceed the output attenuator power dissipation capabilities. Looking back into the attenuator at voltage settings of 5 volts and below, the dissipation capability is approximately 4 watts.

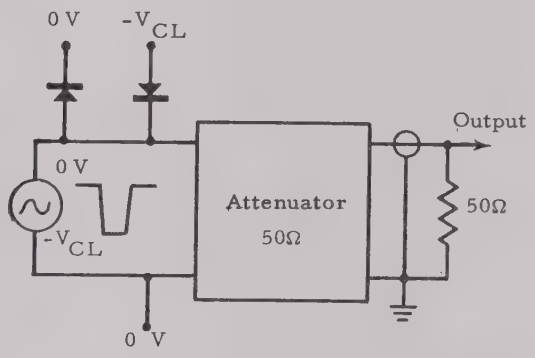


Figure 2-8
Simplified Output Circuit Schematic

CAUTION

When observing, or making any connections to the output circuitry, including its power supply, it is necessary that the output POLARITY SWITCH be on "OFF or "NEG". The unit may be permanently damaged otherwise.

2.3.8 Overload Operation When Operating With Narrow Pulses

On very narrow pulses, increasing the rise time of the output pulse will cause the amplitude to drop, triggering the overload protect circuit.

2.3.9 Ventilation Requirements

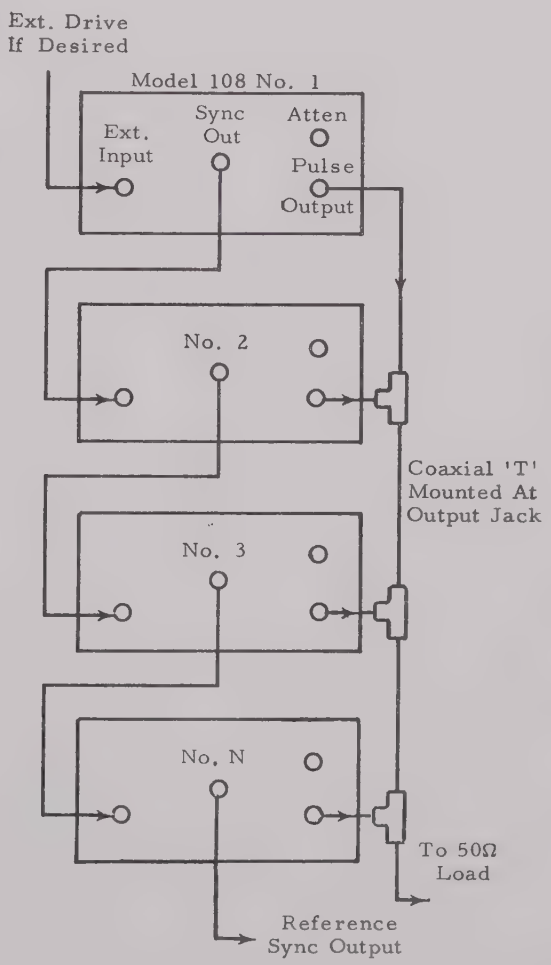
The cooling fan and air filter are located on the rear panel of the Model 108. Leave adequate clearance (at least 2 to 3 inches) behind and at both sides of the instrument for free movement of air. The path of air flow is through the filter and intake fan then out of the perforated side covers. It is important to keep the air intake area free of dust and small particles which could clog the filter.

2.4 SPECIAL APPLICATIONS

2.4.1 Multiple Pulse or Pulse Train Operation Using Several Model 108's (For mixing considerations read 2.3.7)

Magnetic device testing, beacon development, and digital or other pulse code simulation often require multiple pulse or pulse train signals. Multiple DATAPULSE 108 Pulse Generators, when properly connected, will satisfy a broad range of requirements of this type.

Figure 2-9
Wiring for Multiple Pulse Output



Note: Sync occurs approx. .13μs after ext. trigger. Reference sync will occur N x .13μs after external trigger if N equals the number of generators.

2.4.1 (continued)

Mixing the outputs of several 108's, instead of purchasing a special purpose multi-pulse generator, offers many advantages. First, pulse parameters may be controlled individually; second, all pulses are selectable in polarity--a feature not always available on multi-pulse generators; third, such an arrangement is more versatile since the individual units may be broken down for use on other projects; and fourth, the combination of simple, proven, easily operated 108's is more dependable than complex special gear.

The 108's may be driven in parallel from an external source, if sync with outside phenomena is desired, or driven in tandem (see Figure 2-9) using the sync output of one generator to externally drive the next. The first generator may be driven from an external source in the tandem arrangement also. Because of the fast rise character of the pulses and narrow widths available, pulse repetition rates approaching 50 mc may be synthesized.

The termination of interconnecting cables has an important effect on output waveform in this arrangement. Improper termination causes reflections which deteriorate wave shape and increase the rise time. However, good waveform fidelity can be obtained by inserting some measure of attenuation (the amount varying with the number of generators) at the generator end with the internal attenuator. The 50Ω output impedance of the attenuator tends to terminate the interconnecting cables. The greatly decreased waveform distortion more than offsets the slight loss of amplitude sustained. (See Section 2.3.7)

SECTION III

THEORY OF OPERATION

3.1 BLOCK DIAGRAM DESCRIPTION

3.1.1 Pulse Generating Circuit

A pulse repetition rate (W1) is developed by the internal oscillator. Either this signal or an external trigger input is applied to the Schmitt trigger circuit which provides a standardized trigger (W2). W2 is delayed 130 nanoseconds and amplified to become the sync output pulse (W4) which is used as a zero time reference for the pulse delay function. W2 is amplified by the clock driver, provided the external gate input allows it, and triggers the Delay One-Shot multivibrator which produces the delay gate (W5). The trailing edge of W5 is differentiated by a pick-off amplifier yielding the delayed trigger (W6). The delayed trigger (W6) triggers the Width One-Shot producing the width gate (W7). The trailing edge of W7 is differentiated by a pick-off amplifier yielding W7, the "Trailing Edge Trigger". W5 is delayed and differentiated producing W8, the "Leading Edge Trigger". W9 and W8 are used to trigger the pulse forming Flip-Flop. The Flip-Flop produces W10 which drives the output power amplifier. The power amplifier transforms W10 into a high power pulse W11 which may be attenuated by a constant impedance attenuator to a desired level to produce W12.

The Flip-Flop and output amplifier are isolated from the Front End Circuitry by means of trigger coupling transformers. Either positive or negative output pulses are obtained by a reversing switch on the output leads.

3.1.2 Overload Protection Circuit

Because of the limited power dissipation, low breakdown voltages, and very short thermal time constants of the output transistors, circuitry is required to protect against possible transistor destruction due to short circuits or low resistance loads. The overload circuitry in the 108 performs two basic functions.

(1) When the output drops below 40 volts during pulse time a circuit turns off the pulse forming unit until the next leading edge trigger appears.
(2) A circuit immediately disables the leading edge triggers for approximately two seconds and turns on an overload indicator lamp. This circuit eliminates the possibility of high duty cycle overload at fast repetition rate settings.

3.1.2.1 Pulse Forming Reset Circuit Description (Fig. 3.1.a): Under normal conditions W11A is formed by the clipping action of CR331 and R345. This pulse is fed through Q313, Q312, Q311 and to the base of Q310. W16 is somewhat wider than W11A due to the biasing of Q311 and the slow fall time of W15. Q310 is normally biased on but is off during the time W16 is positive. W13 is fed through DL330 and will turn itself off after .1 μsec if W16 is not positive by that time. In other words, after the initial .1 μsec. delay of DL330, if W11 drops below 40 volts, W11A will drop to -40 V and W16 will go negative causing Q310 to conduct through Q309, which is already on, returning W13, and therefore the current drive to the output, to its "OFF" state.

3.1.2.2 Trigger Hold Off & Overload Lamp Indicator Circuit Description (See Fig. 3.1 b): Under normal conditions this circuitry is inoperative due to W11A biasing off Q307 when the output is operating.

When the output drops below 40 volts, due to overload, W11A returns to -40 volts causing Q307 to be biased on. The next trailing edge trigger W17 which occurs will cause Q306 to conduct through Q307, forming W18. W18 triggers a two second multivibrator which supplies gate for holding off all leading and trailing edge triggers and drives a front panel overload indicator lamp.

The two second multivibrator is actually two multivibrators in tandem, allowing for immediate reset in case of prolonged overloads.

NOTE: On very narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop, triggering the overload protect circuit.

CAUTION

When observing, or making any connections to the output circuitry, including its power supply, it is necessary that the output POLARITY SWITCH be on "OFF" or "NEG". The unit may be permanently damaged otherwise.

3.2 CIRCUIT DESCRIPTIONS

3.2.1 Internal Oscillator

The internal oscillator is an emitter coupled RC oscillator which functions as follows:

Assume Q2 has just begun to conduct, its collector dips negative. This signal on the base of Q3 drives its emitter negative. The negative signal at the emitter of Q3 is coupled across C_t to the emitter of Q2 causing conduction to increase. The increase of conduction through Q2 causes its collector to dip more negative, regeneratively driving Q2 toward saturation until the clamp voltage of the anode of CR1 is reached. C_t charges through Q2, R6, and R10. As C_t becomes charged to the signal voltage, its contribution to the current through R6 will decrease. As the current through R6 decreases, the collector of Q2 moves positive. This positive going signal on the base of Q3 causes the emitter of Q3 to move positive and the positive going waveform is coupled across C_t to the emitter of Q2 decreasing conduction. As conduction of Q2 decreases its emitter becomes more positive regeneratively cutting off Q2. C_t now discharges through R_t and Q3. When C_t has discharged down to the level set at the base of Q2, Q2 will again begin to conduct and the cycle will be repeated. The negative spike at the collector of Q2 is emitter-follower coupled to the Schmitt trigger circuit by Q4. Q1 provides a low impedance clamp voltage for CR1.

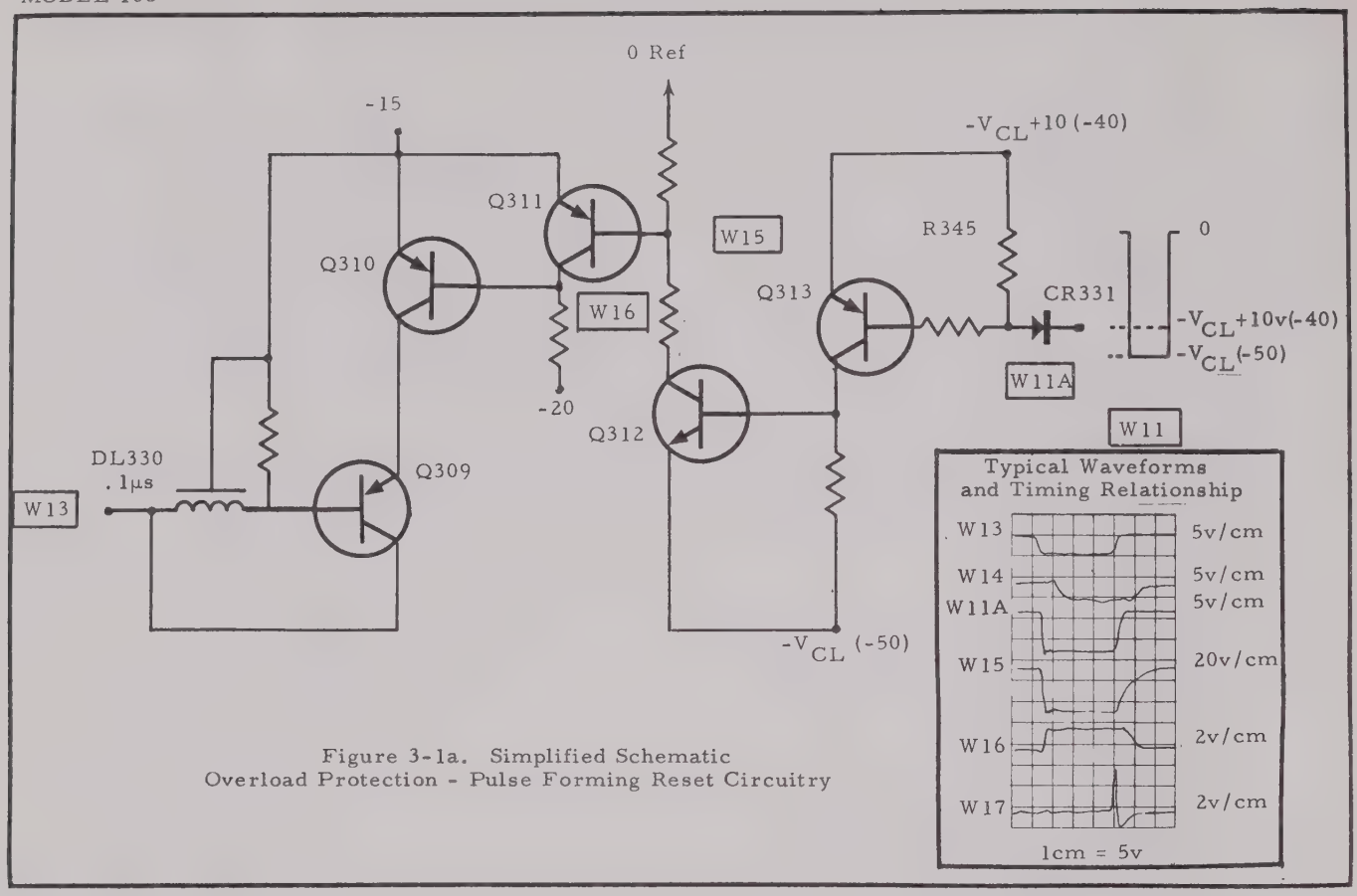


Figure 3-1a. Simplified Schematic
Overload Protection - Pulse Forming Reset Circuitry

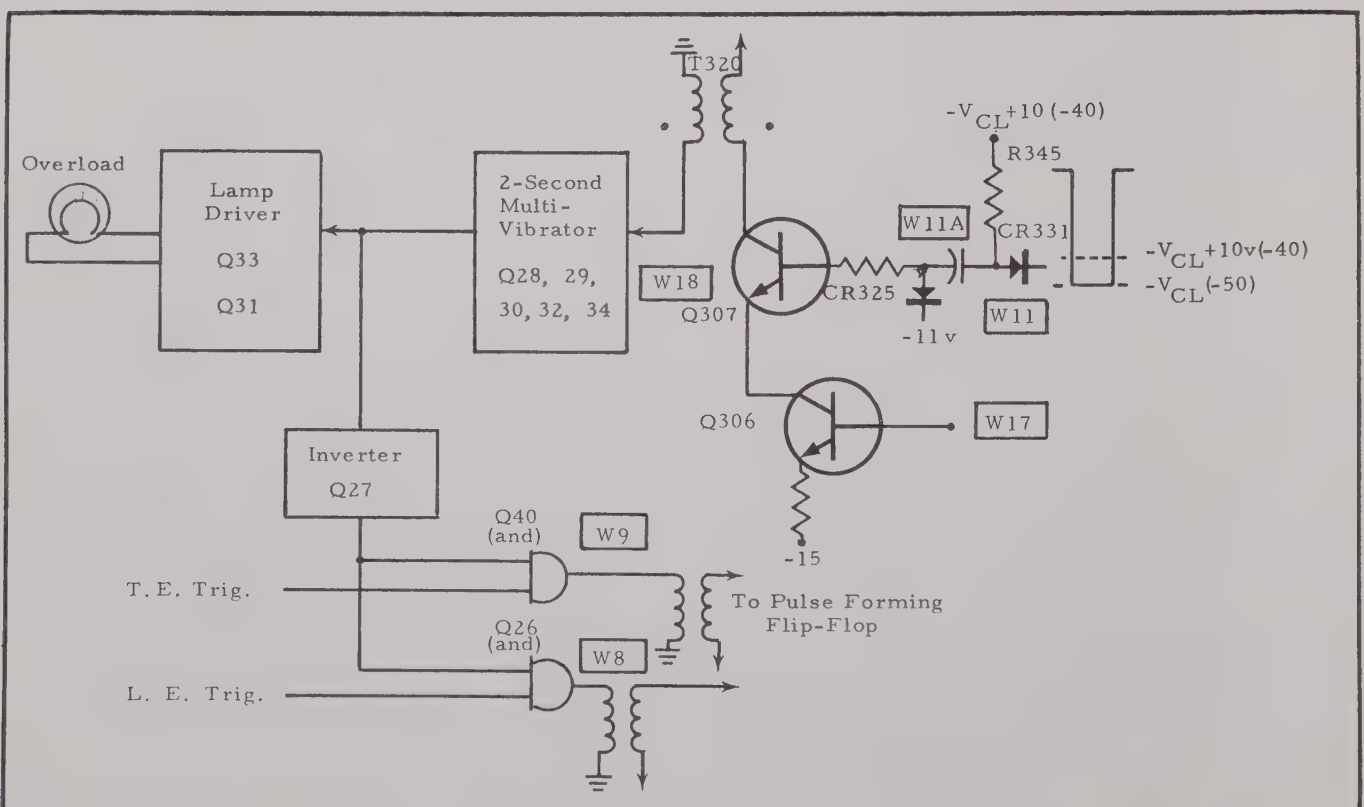


Figure 3-1b. Simplified Schematic
Overload Protection - Trigger Hold-Off and Overload Lamp Indicator Circuitry

3.2.2 Schmitt Trigger Circuit

The Schmitt circuit is used to standardize waveforms either from the internal oscillator or external triggers having varying wave shape. Because of regeneration during switching, the output of the Schmitt circuit has relatively constant rise time regardless of input wave shape. The operation is as follows:

Initially, Q5 is conducting. Both the emitter of Q5 and the emitter of Q6 are approximately at the base potential of Q5 which is set by the voltage divider composed of R40, R41, and R42. The collector of Q5 is clamped by CR40 to another point on the divider. The base of Q6 is set by the divider consisting of R45 and R47 to a point more negative than its emitter. Therefore, Q6 is cut off.

Upon the application of a negative going signal to the base of Q5, conduction decreases. As conduction of Q6 decreases, its emitter and the emitter of Q5 become less positive; increasing the conduction of Q5, lowering its collector potential, decreasing conduction of Q6, regeneratively cutting off Q6; and the circuit returns to its static state.

Positive going inputs initiate "switching" at the base of Q6 and the rest of the cycle is similar to that for negative triggering.

Output of the circuit is taken from the collector of Q6.

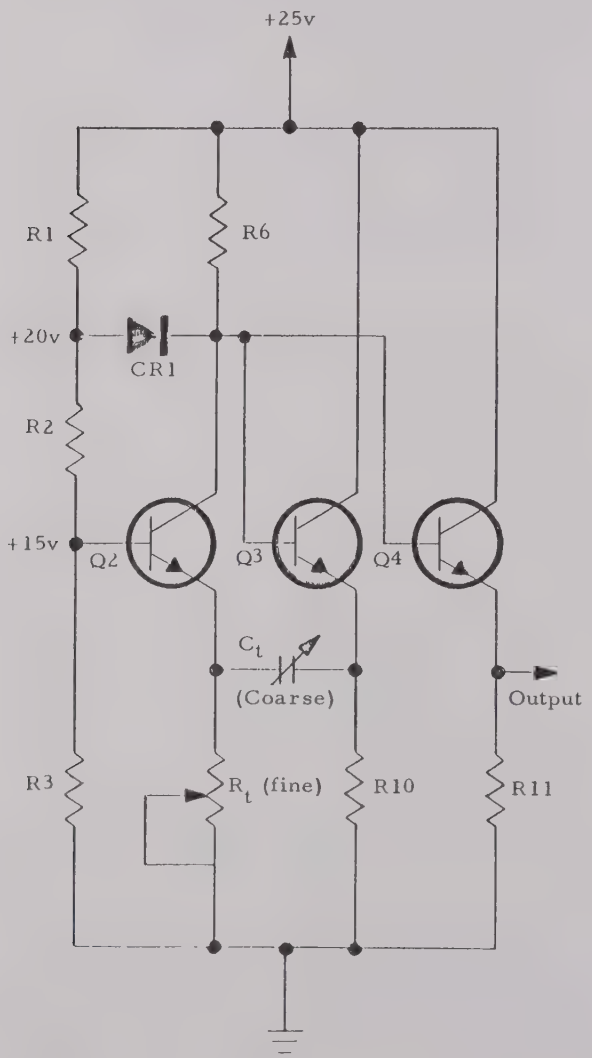


Figure 3-2. Simplified Internal Oscillator.

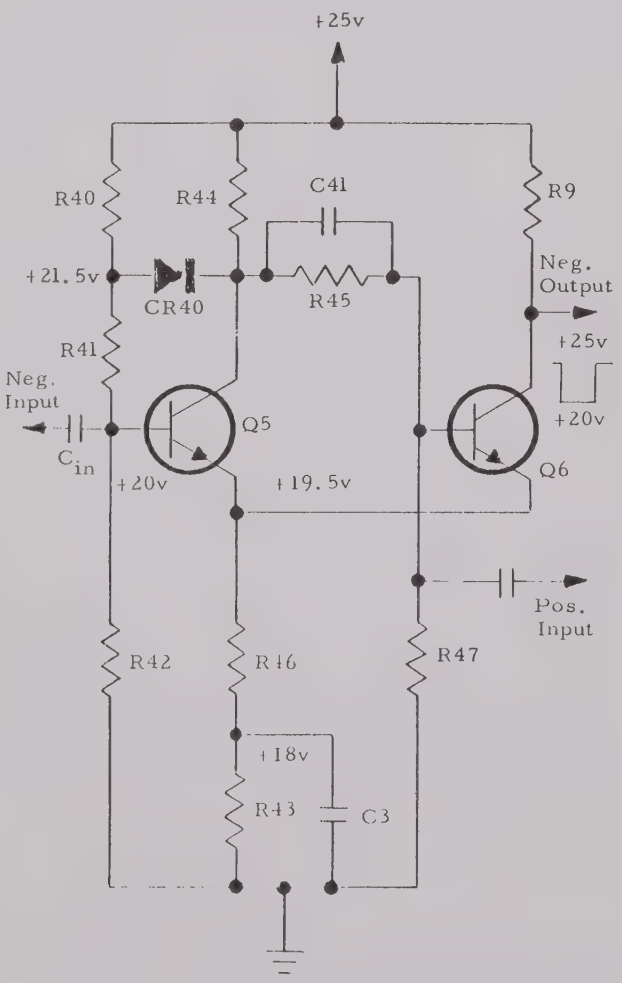


Figure 3-3. Simplified Schmitt Trigger.

3.2.3 One-Shot Multivibrator (Fig. 3-4)

The pulse delay circuitry is an emitter coupled one-shot multivibrator. As pulse width is essentially a delay function (i.e., the delay of trailing edge with respect to leading edge), the same technique is used to perform both operations. The circuit functions as follows:

In the static state Q13 is held on by the bias developed across CR73 and CR75. The collector of Q13 is clamped at approx. -4v by CR74. Upon the application of a negative trigger at the base of Q13, Q13 is turned off and its collector rises toward +25v, but is clamped at ground by CR76. This positive step is emitter-follower coupled to C_t by Q14, coupled across C_t and through emitter followers Q15 and Q16 back to the emitter of Q13. C_t now begins to charge through R_t, R76, and Q14. When C_t has charged to the signal voltage, Q13 again begins to conduct. The collector of Q13 drops back to the -4v clamp level and C_t discharges through R74, R76, and CR77.

Output is taken off of collector at Q13. This gate is delivered to the pickoff amplifier to obtain leading or trailing edge output pulse triggers.

3.2.4 Pickoff Amplifier (Fig. 3-5)

The pickoff amplifier uses a non-inverting transformer (T110) to differentiate the gate produced by the delay and width one-shot multivibrators. Its operation is as follows:

Initially, steady state current flows in Q17 and the primary of T110. The base of Q18 is biased at -5v. As Q18 is an emitter follower, its emitter is at approximately -5v and holds Q19 cutoff. The collector of Q19 is clamped at ground by CR110.

At the initiation of the input gate, the base of Q18 is driven positive increasing conduction. This causes the collector to dip negative as a magnetic field is built up in T110. The negative going signal is applied to the base of Q18 and then to the base of Q19. As Q19 is already cut off no change takes place in its collector circuit. The magnetic field in T110 is soon built up and negative pulse subsides.

At the termination of the input gate, the negative going trailing edge causes current in Q17 to decrease and the field in T110 collapses causing a positive spike at the base of Q18. This positive spike is coupled to the base of Q19. Q19 then conducts driving its collector sharply negative, producing a negative delayed trigger.

3.2.5 Output Amplifier and Pulse Forming Circuitry (Refer to Drawing DPJ40000-056)

The output amplifier driving pulse is formed through the use of a bistable multivibrator which is triggered by the leading and trailing edge triggers from the pulse width and delay one shot multivibrators. The formed pulse from the bistable circuit is amplified by several stages of emitter followers, complimentary emitter followers and one inverter to raise the voltage of the pulse.

The output transistors are in a common-base configuration and would be driven slightly into saturation except for the use of clamp diodes which limit the collector to base voltage to approximately 4v. If the clamp diodes were not used, storage effects caused by the relatively high Qt in the output transistors would distort the output pulse considerably. A simplified circuit description of the output is as follows (Refer to Fig. 3-6).

In the static state the emitter of Q1 is more positive than $-V_b$ by the drop across CR1 and V_{be} Q1. This places the emitter of Q2 more positive than its base and therefore in a cutoff condition. Upon the application of a negative signal to the base of Q1, the base emitter diode of Q2 is forward biased, and a current of magnitude $\frac{\text{E signal}}{\text{R emitter}}$ flows in the emitter of Q2. A current of Alpha (approximately .95 to .98) times the emitter current flows in the collector of Q2 and through the load R_1. As the negative input pulse subsides, the circuit reverts to the static state. The clamp voltage ($-V_{cl}$) limits the amplitude of the output pulse and is varied approximately 20% to provide the continuous fill-in between the constant impedance attenuator voltage settings.

3.2.6 Reversing Pulse Polarity (Fig. 3-6)

Pulse polarity is reversed by merely reversing the connections between the center conductor and shield of the coaxial cable carrying the pulse. Polarity Switch S390 performs this function. This method of reversing polarity is possible because a floating power supply is used allowing the ground reference to be established at any level. Negative pulse outputs occur when the collectors of the output transistors drive the center conductor of the 50Ω coax and the 0v Reference is tied to the shield. Positive pulses occur by reversing these connections and placing the 0v reference at the center conductor. The capacity of the 0v reference to the instrument chassis would load the positive polarity pulse were it not for the balun choke (L390) effectively isolating this capacity from the chassis. The 0v reference capacity to the chassis is kept at a minimum through the use of a low capacity power transformer T400 and careful circuit layout.

CAUTION

When observing, or making any connections to the output circuitry, including its power supply, it is necessary that the output polarity switch be on "OFF" or "NEG". The unit may be permanently damaged otherwise.

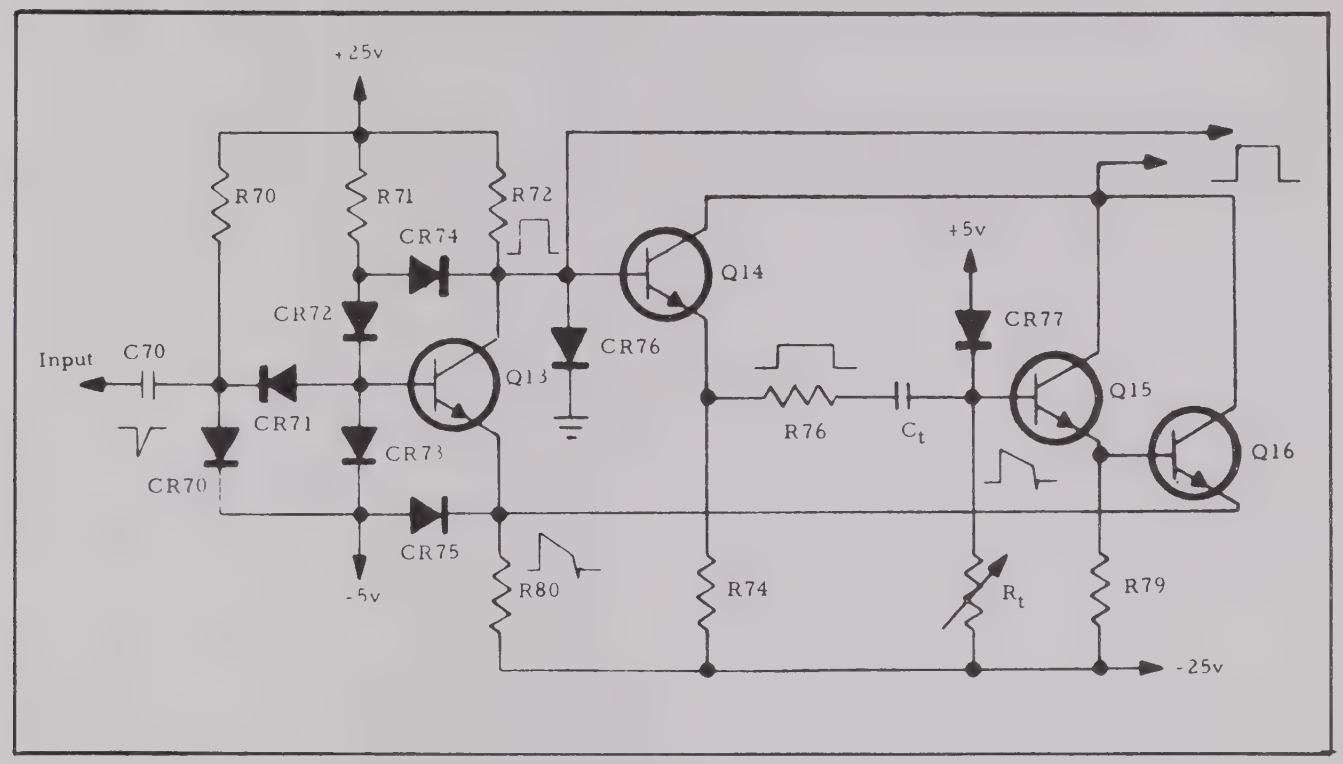


Figure 3-4. Simplified One-Shot Multivibrator

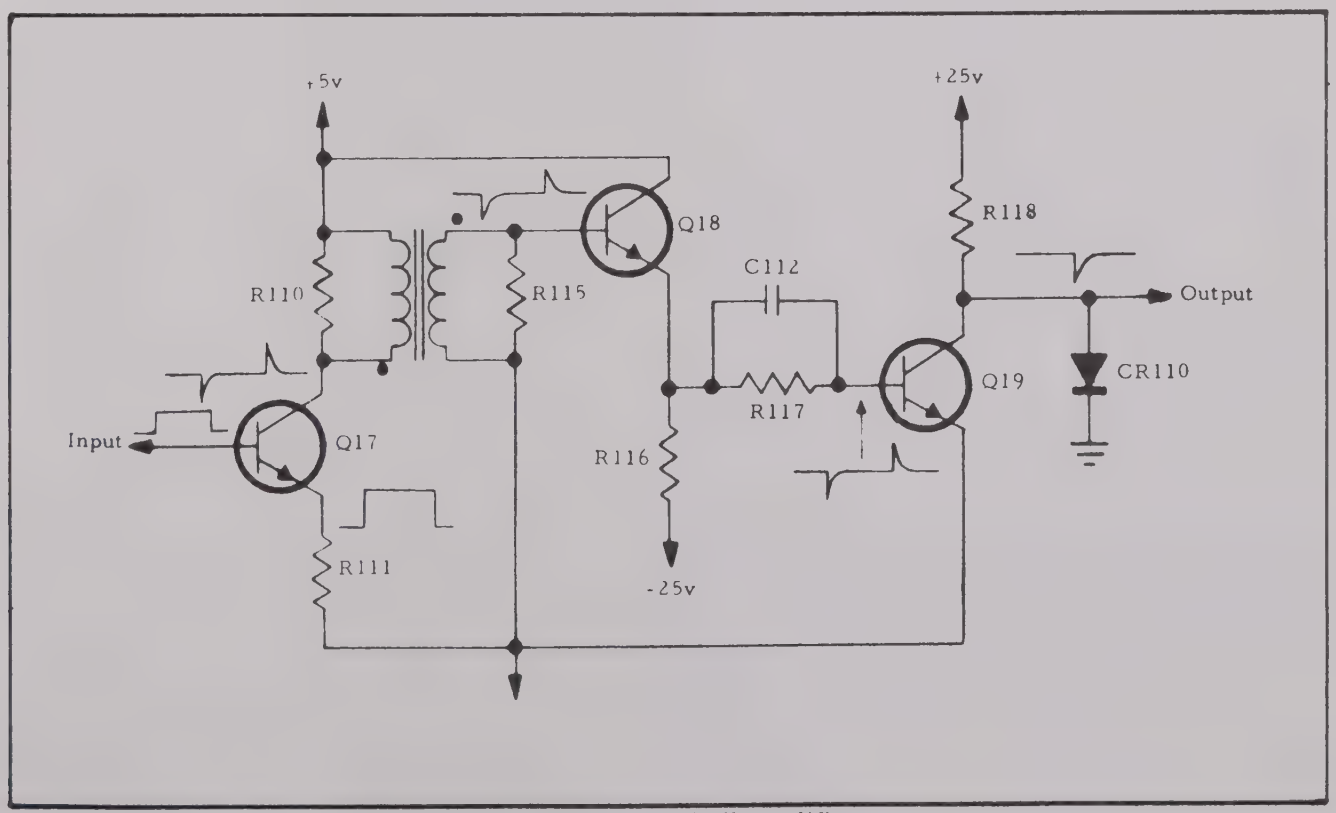


Figure 3-5. Pickoff Amplifier

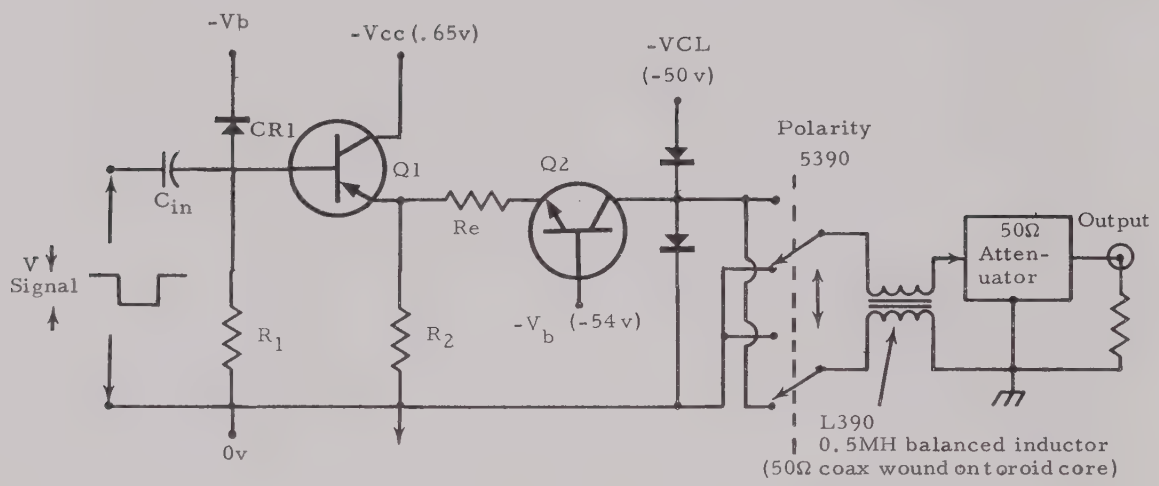


Figure 3-6. Simplified Output Circuit Schematic

MAINTENANCE INSTRUCTIONS

4.1 PREVENTIVE MAINTENANCE

4.1.1 Preventive Inspection and Service

Inspection and service of a preventive nature will result in optimum performance and longer life of this instrument. Dust covers should be removed at regularly scheduled intervals to permit inspection for dust, tarnish, corrosion, loose nuts and bolts (especially those serving as electrical conductors), loose cables and fuses, charred insulation, scorched resistors and broken wiring. Discoloration of the printed circuit board, due to heat, does not affect the board's electrical properties and may be disregarded in most cases.

4.1.2 Minor Repairs

The operator should be thoroughly acquainted with the instrument's circuit theory and component location before attempting repair. In all cases, setting and adjustment of controls should be checked in order to verify that difficulties encountered are actually caused by malfunction and not by operation outside of specifications. Check transistors in suspected circuits prior to conducting extensive tests on other components.

4.1.3 Recalibration

This instrument was designed to provide maximum reliability and stability. To insure that accuracy remains within stated limits, we suggest that calibration be checked after every 200 hours of operation. See Section 4.5 for calibration check. If the unit is used intermittently, calibration should be checked every three months. Complete instructions for calibration are given in this manual.

4.2 PARTS REMOVAL AND REPLACEMENT

4.2.1 General

This instrument is sturdily built and easily accessible. Removal of most parts is so simple that explanations are unnecessary. However, some parts are more easily removed if a definite procedure is followed. Replacement of some parts will also require partial recalibration. Refer to Section 4.4 of this manual for calibration instructions.

4.2.2 Removal of Dust Covers

The dust covers are held in place by small screw-head fasteners. To remove, turn the fasteners a quarter turn counterclockwise with a common screwdriver. To remove the top dust cover: (1) loosen the four fasteners in the sides of the bottom dust cover; (2) remove the four fasteners on the sides of the top dust cover; (3) loosen the two fasteners on the top of the dust cover; and (4) lift the cover up and off.

To remove the bottom dust cover: (1) turn the instrument upside down; (2) remove the four fasteners on the sides of the bottom cover; (3) loosen the four fasteners on the bottom of the cover; and (4) lift the cover up and off.

4.2.3 Replacement of Power Transistors

The power transistors which are mounted to the rear panel must have a thin film of silicon grease (such as Dow-Corning DC-4) applied to their common contact surfaces.

4.2.4 Soldering Considerations

Although printed wiring is quite vulnerable to heat excesses, a great deal of resoldering can be done on a single joint if care is taken. A 35-watt wedge tip or pointed tip iron and 60-40 rosin core solder are quite effective. Where both sides of the board are accessible apply the tip of the iron (on the side opposite the component) directly to the solder fillet and pull gently on the pigtail with pliers from the opposite side. Where both sides of the circuit board are not accessible, the component lead will be fed through the board through an eyelet. Apply the iron tip to the eyelet and pull the pigtail out with the pliers. To insert a new component, clean out the hole with a sharp object (it may be necessary to apply more heat) and insert the new component, soldering in the old place.

4.3 TROUBLESHOOTING PROCEDURE

Before any troubleshooting is attempted, the front panel controls should be checked for proper setting. You may wish to refer to paragraph 2.3, "Operating Considerations" which details many of the limitations of the instrument and describes the performance to be expected. After you have ascertained that a trouble does exist, you may continue according to the procedures outlined in this section.

Many apparent malfunctions are due to improper calibration of one or more of the circuits, and often a transistor is replaced that required recalibration. If you suspect that a circuit is miscalibrated, refer to Section 4.5 of this manual which describes a procedure for determining calibration status. Section 4.4 provides a detailed calibration procedure.

Whenever trouble occurs, check the power supply voltages. This test may be done by following paragraph 4.4.3 of the "Calibration Procedure". It may be assumed that the power supplies are functioning properly if the output and ripple voltages are correct.

When malfunction can be attributed to a particular circuit, perform a complete visual inspection in that area. See Figure 4-1 for the location of circuits. Frequently, visual inspection reveals the effects of the trouble (such as burned resistors) rather than the cause. However, these effects may give clues as to the actual cause. Care should be taken to find the real cause.

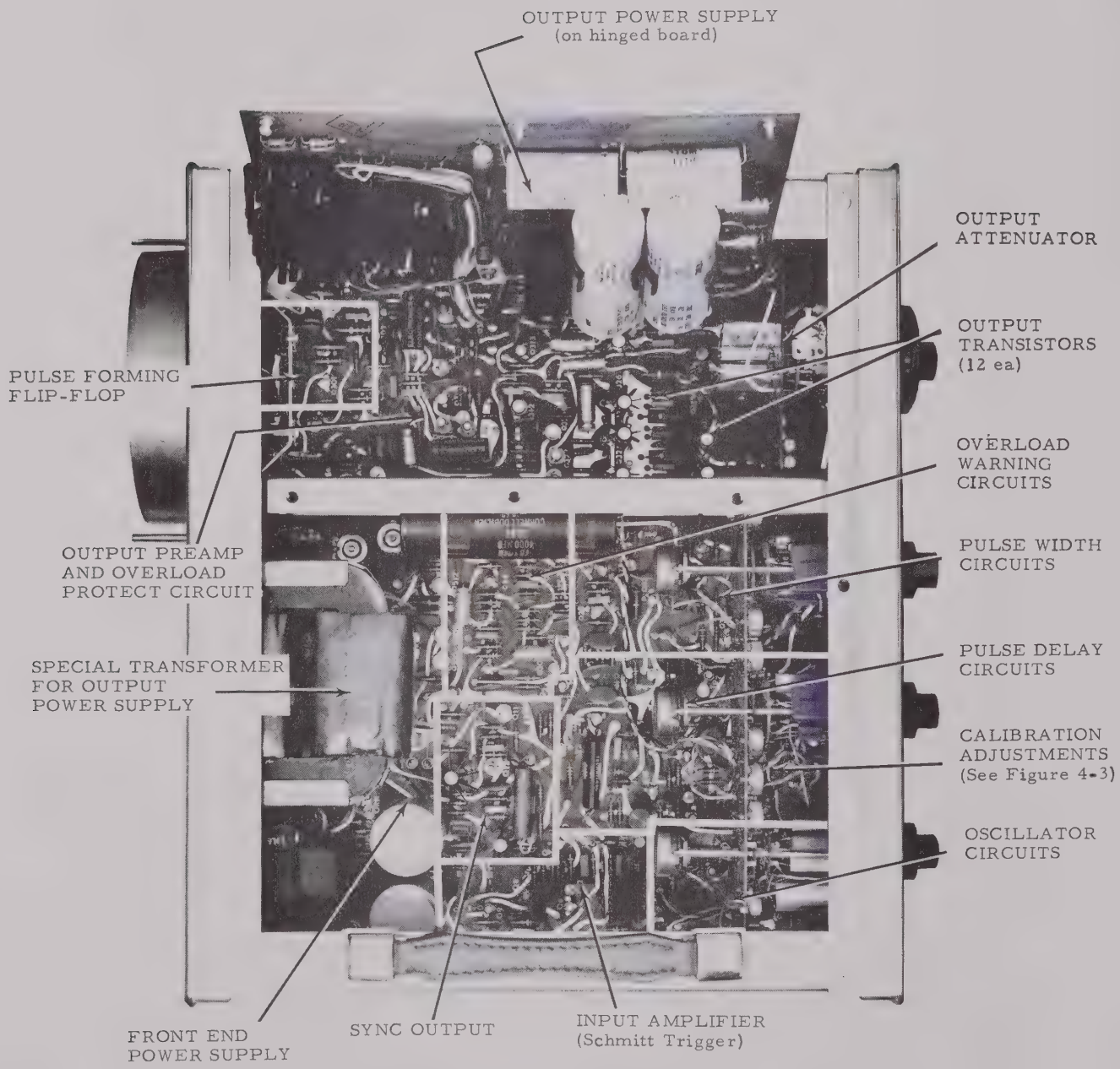


Figure 4-1. Circuit Locations.

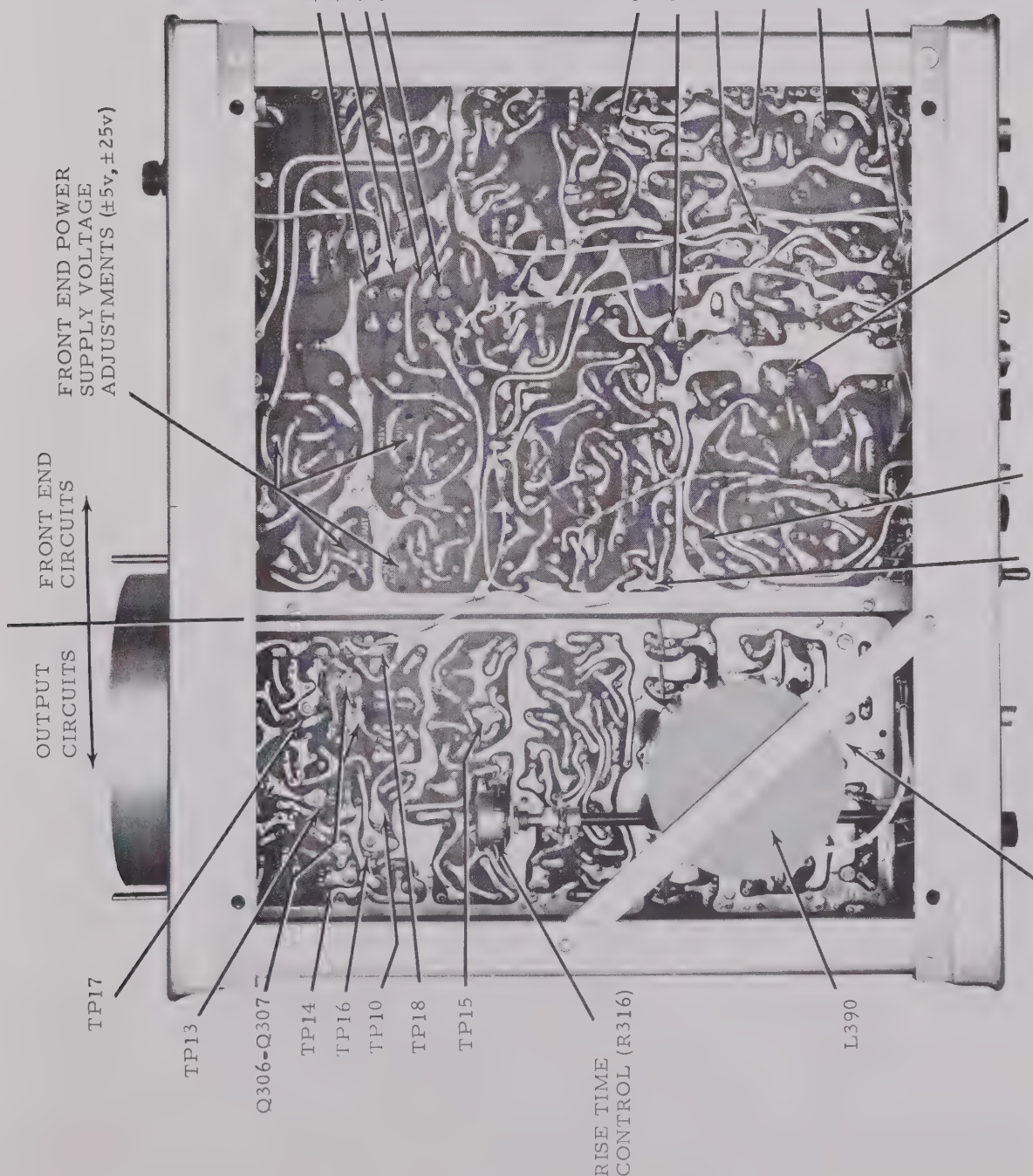


Figure 4-2. Adjustment and Test Point Locations.

4.3.1 Troubleshooting the Power Supplies

Almost all power supply failure may be typified by collector to emitter shorts (transistors) and anode to cathode shorts (rectifiers and zener diodes). These conditions are easily detected "in circuit" with an ohmmeter because they measure very low resistance in both directions.

4.3.2 Troubleshooting the Pulse Circuits

Once it has been ascertained that the power supplies are functioning correctly, the most straightforward method of tracking down a trouble is to begin at test point #1 and proceed through the instrument comparing waveforms to those listed in the schematic. This will generally narrow the trouble down to one of a very few components. Because of the "straight through" nature of the instrument circuitry, most troubles will manifest themselves as complete absence of output pulses or invariability of one or more of the pulse parameters. In the later case, a good indication is given as to which circuit to suspect.

4.4 CALIBRATION PROCEDURE

4.4.1 General

Remove dust covers and connect instrument and ac voltmeter to auto transformer. Set to 115v ac (230v if so wired) and energize instrument. Allow five minutes warm up before commencing calibration. During this period make sure that the instrument is working properly. If any portion of the instrument fails to calibrate, repair should be effected before attempting to complete calibration.

4.4.2 Equipment Required

a) RMS reading ac voltmeter with 0-150v range (0-300v range if wired for 230v operation).

b) Variable line auto transformer such as Powerstat Series 20.

c) A multimeter with an accuracy of at least 3% and a sensitivity of 20,000 ohms per volt. Triplett 630 or equivalent.

d) A general purpose oscilloscope of at least 30 mc band-pass with either delayed sweep or high sweep magnification. Hewlett-Packard 175A or Tektronix 543 is adequate.

e) A wide band oscilloscope such as HP Model 185B or Tektronix 661 is necessary for fine adjustment of output waveform.

f) 50 ohm 1%, 5w termination, Datapulse 2002A.

g) An insulated, low-capacity screw driver.

h) Optional: 10 mc counter HP Model 5243 or equivalent.

4.4.3 Power Supply Calibration

As the timing circuits are dependent upon the regulated power supply voltages for reference, any variances of these voltages will necessarily cause a change in calibration accuracy. Therefore, these adjustments should not be attempted unless one is prepared to carry out complete recalibration.

Due to internal referencing within the power supply, the following sequence of adjustment must be followed: (output voltages are measured with respect to "0 Ref").

a) Connect a dc voltmeter from +25v test point to ground. Set R516 (+25v adj.) for a reading of 25v. Vary line voltage ±10% around 115v and verify regulation.

b) Connect dc voltmeter from +5v test point to ground. Set R522 (+5v adj.) for a reading of 5 volts.

c) Connect dc voltmeter from -25v test point to ground. Set R536 (-25v adj.) for a reading of 25 volts. Vary line voltage ±10% around 115v and verify regulation.

d) Connect dc voltmeter from -5v test point to ground. Set R539 (-5v adj.) for a reading of 5 volts.

e) Check ripple on all supplies. Ripple should be less than 30 mv peak-to-peak.

f) Connect dc voltmeter from $-V_{cc}$ to 0 Ref. Set amplitude vernier (located on front panel) fully CW. Set R408 (max. ampl.) for a reading of 67 volts. Vary line voltage ±10% around 115v and verify regulation.

g) Connect dc voltmeter from $-V_{cl}$ to 0 Ref. Set R442 ($-V_{cl}$ adj.) for a reading of 50 volts. Vary line voltage ±10% around 115v and verify regulation.

h) Connect dc voltmeter from -50v to 0 Ref. Set R423 (-50v adj.) for a reading of 50 volts.

i) Connect dc voltmeter from -20v to 0 Ref and verify a reading of between 19 and 21 volts.

j) Connect dc voltmeter from -15v to 0 Ref. Set R426 (-15v adj.) for a reading of 5 volts less than what the 20v supply reads. (see (i) above).

k) Connect dc voltmeter from -25v to 0 Ref. Set R429 (-25v adj.) for a reading of 5 volts more than what the 20v supply reads. (See (i) above).

TABLE 4-1
REPETITION RATE ADJUSTMENT

Rep. Rate Range	Vernier Position (R36)	Adj. To Be Made	Counter Reading	Pulse Spacing for Scope Calibration
0.1kc	cw	0.1kc UL(R32)	100cps	10ms
0.1kc	ccw	LL(R28)	10cps	0.1sec.
1kc	cw	1kc UL(R31)	1kc	1ms
1kc	ccw	LL(R28)	< 100 cps	10.0ms
10kc	cw	10kc UL(R30)	10kc	0.1ms
10kc	ccw	LL(R28)	< 1.0 kc	1.0ms
0.1mc	cw	0.1mc UL(R29)	100kc	10μs
0.1mc	ccw	LL(R28)	< 10 kc	100μs
1mc	cw	1mc UL(R27)	1mc	1μs
1mc	ccw	1mc LL(R28)	< 100 kc	10.0μs
10mc	cw	C4 (10mc UL	10mc	0.1μs
10mc	ccw	10mc LL(R26)	1.0mc	1.0μs

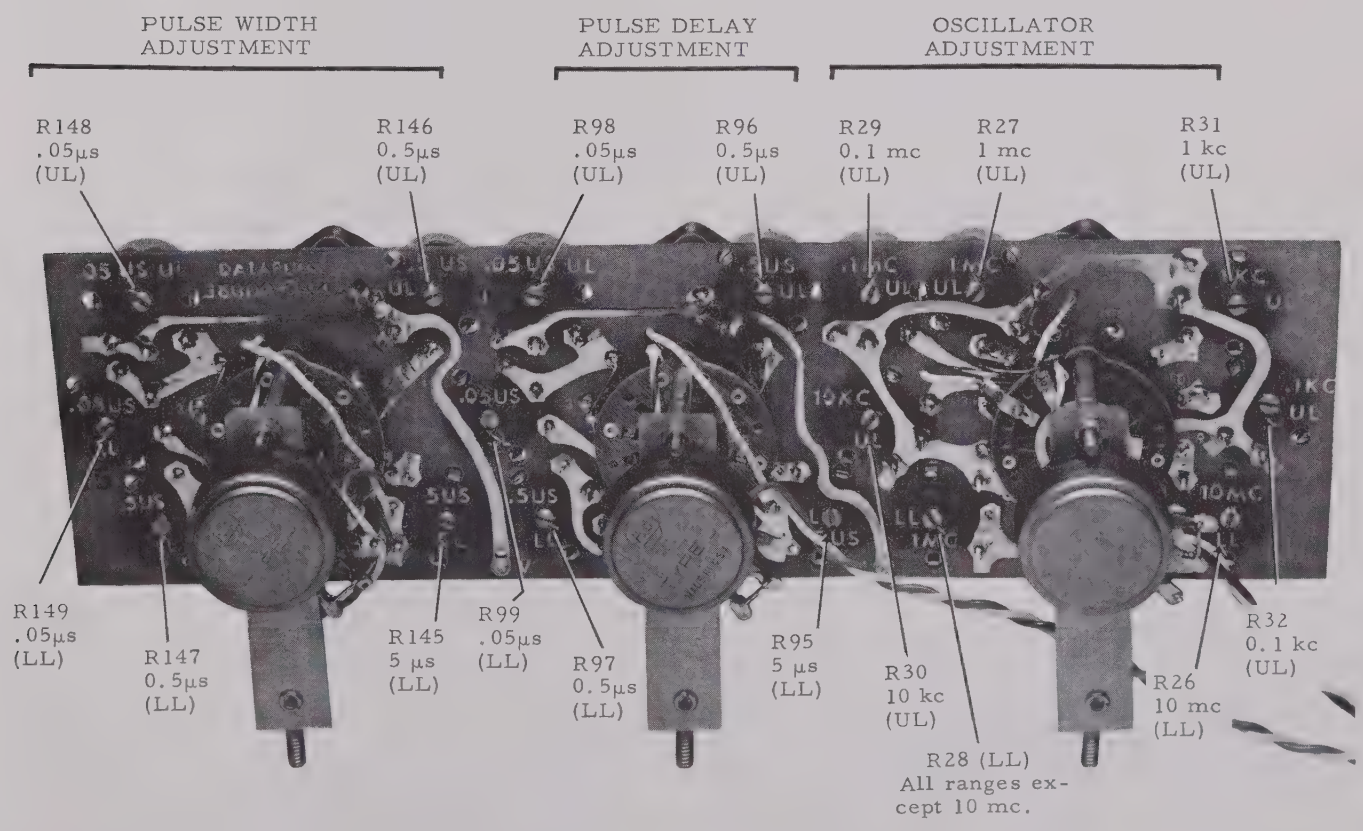


Figure 4-3. Calibration Adjustments

4.4.4 Repetition Rate Calibration

NOTE: As calibration accuracy of most oscilloscopes is in the range of ±5%, the ultimate calibration accuracy of the instrument is limited by this value, i.e., if the instrument is calibrated using an oscilloscope which is 5% off in one direction and is then checked with another which is 5% off in the opposite direction, a 10% deviation will be shown. If calibration is performed using a frequency meter type of counter such as HP Model 5243, driving the counter with the positive sync pulse output, calibration accuracies of 1% or better can usually be obtained. However, one must bear in mind that if the output is then viewed on a 5% oscilloscope, this accuracy may appear as 6%. The following procedure is given for calibration of repetition rate using a counter.

a) Set DELAY and WIDTH controls to 0.05 μs with VERNIER fully ccw.

b) Adjust oscillator according to Table 4-1. The deviation on the lower limit (LL) adjustment is to provide a small measure of overlap of ranges and assure continuous coverage of all frequencies. The reason for adjusting upper limit (UL) first is that the upper limit adjustment affects both ends of the range while the upper limit is independent of lower limit setting. When using oscilloscope for calibration, view the positive pulse output terminated into 50 ohms with a 10 ns rise time. Widen pulse as necessary for oscilloscope presentation.

c) Recheck oscillator according to Table 4-2. It may be necessary to compromise setting of R28 (lower limit) so that the lower limit at the 1 mc through 0.1 kc ranges is within specification (i.e., less than the stated values).

TABLE 4-2
CHECK OF REPETITION RATE ADJUSTMENTS

Rep Rate Range	Vernier Position (R36)	Counter Reading ≥ +5% -0%	Pulse Spacing for Scope Calibration
0.1kc	cw	≥ 100cps	10ms
0.1kc	ccw	< 10cps	0.1sec
1kc	cw	≥ 1kc	1ms
1kc	ccw	< 100cps	10. ms
10kc	cw	≥ 10kc	0.1ms
10kc	ccw	< 1kc	1ms
0.1mc	cw	≥ 100kc	10μs
0.1mc	ccw	< 10kc	100μs
1mc	cw	≥ 1mc	1μs
1mc	ccw	< 100kc	10μs
10mc	cw	≥ 10mc	0.1μs
10mc	ccw	< 1mc	1.0μs

4.4.5 Pulse Delay Calibration

Delay is measured from the 50% point on the leading edge of the positive sync output pulse to the 50% point on the main pulse output. Pulse delay accuracy is defined for minimum output pulse rise time.

NOTE: For calibration of pulse delay, a dual trace oscilloscope is convenient but not mandatory. To use a single channel oscilloscope, first view the positive sync output and align the 50% point of the leading edge with the left hand edge of the graticule by using the horizontial position control. Next, view the main pulse output and make delay measurement using the left hand edge of the graticule as a reference. For dual trace oscilloscope, view sync on one trace and the output pulse on the other.

a) Pulse spacing $\left(\frac{1}{\text{repetition rate}}\right)$ must be kept at least ten times the delay setting. Set PULSE WIDTH to 0.5 μs.

b) Adjust delay according to Table 4-3 the long upper limit calibration points are to insure overlap at ranges giving continuous coverage.

TABLE 4-3
DELAY CALIBRATION ADJUSTMENT

Delay Range	Vernier Position (R100)	Adjustment	Set Delay for	Scope Sweep Speed (per cm)	Rep. Rate
0.05μs	ccw	0.05μs LL(R99)	0ns	20ns	0.1mc
0.05μs	cw	0.05μs UL(R98)	0.52μs	0.1μs	0.1mc
0.5μs	ccw	0.5μs LL(R97)	0.5μs	0.1μs	10kc
0.5μs	cw	0.5μs UL(R96)	5.2μs	0.5μs	10kc
5μs	ccw	5μs LL(R95)	5μs	0.5μs	1kc

c) Recheck delay calibration according to Table 4-4. It may be necessary to compromise the adjustment of R95 (5μsLL) such that the lower limit of the 0.05 ms and 0.5 ms ranges is within specifications. It may be necessary to compromise the adjustment of R96 (0.5 μs UL) such that the upper limit of 5 μs, 0.05 ms and 0.5 ms ranges is within specifications.

TABLE 4-4
CHECK OF DELAY CALIBRATION ADJUSTMENTS

Delay Range	Vernier Position (R100)	Set Delay For ≤ = +0% -5%, ≥ = +5% -0%	Scope Sweep Speed (per cm)	Rep. Rate
0.05μs	ccw	0ns	20ns	0.1mc
0.05μs	cw	≥ 0.5μs	0.1μs	0.1mc
0.5μs	ccw	≤ 0.5μs	0.1μs	10kc
0.5μs	cw	≥ 5.μs	0.5μs	10kc
5μs	ccw	≤ 5μs	0.5μs	1kc
5μs	cw	≥ 50μs	5μs	1kc
0.05ms	ccw	≤ 50μs	5μs	0.1kc
0.05ms	cw	≥ 0.5ms	50μs	0.1kc
0.5ms	ccw	≤ 0.5ms	50μs	0.1kc
0.5ms	cw	≥ 5ms	0.5ms	10cps

4.4.6 Pulse Width Calibration

Pulse width is measured from the 50% point on the leading edge to the corresponding point on the lagging edge. Pulse width calibration accuracy is defined for minimum output pulse rise time.

a) Set PULSE DELAY to 0.05 μs, VERNIER Counterclockwise. Pulse spacing $\left(\frac{1}{\text{Repetition rate}}\right)$ must be kept at 10 times the pulse width during calibration.

b) Adjust PULSE WIDTH according to the following chart: the wide upper limit calibration points assure that the ranges overlap to provide continuous coverage.

TABLE 4-5
WIDTH CALIBRATION ADJUSTMENTS

Width Range	Vernier Position (R100)	Adjustment	Set Width For	Scoop Sweep Speed	Rep. Rate
0.05μs	ccw	0.05μs LL(R149)	Min	20ns	0.1mc
0.05μs	cw	0.05μs UL(R148)	0.52μs	0.1μs	0.1mc
0.5μs	ccw	0.5μs LL(R147)	0.5μs	0.1μs	10kc
0.5μs	cw	0.5μs UL(R146)	5.2μs	0.5μs	10kc
5μs	ccw	5μs	5μs	0.5μs	1kc

c) Recheck pulse width according to Table 4-6. It may be necessary to compromise the adjustment of R145 (5μsLL) such that the lower limit of the 0.05 ms and 0.5 ms ranges is within specification. It may be necessary to compromise the adjustment of R146 (0.5μs UL) such that the upper limit of the 5μs, 0.05 ms and 0.5 ms ranges is within specification.

TABLE 4-6
CHECK OF WIDTH CALIBRATION ADJUSTMENTS

Width Range	Vernier Position (R100)	Set Width For ≤ = +0% -5%, ≥ = +5% -0%	Scope Sweep Speed (per cm)	Rep. Rate
0.05μs	ccw	≤ 20ns	20ns	0.1mc
0.05μs	cw	≥ 0.5μs	0.1μs	0.1mc
0.5μs	ccw	≤ 0.5μs	0.1μs	10kc
0.5μs	cw	≥ 5μs	0.5μs	10kc
5μs	ccw	≤ 5μs	0.5μs	1kc
5μs	cw	≥ 5μs	5μs	1kc
0.05ms	ccw	≤ 50μs	5μs	0.1kc
0.05ms	cw	≥ 0.5ms	50μs	0.1kc
0.5ms	ccw	≤ 0.5ms	50μs	0.1kc
0.5ms	cw	≥ 5ms	0.5ms	10cps

4.4.7 Output Circuit Calibration

NOTE: For optimum performance, calibration of the output curcuits requires the use of a high bandpass oscilloscope such as the HP Model 185B.

CAUTION

When observing or making any connections to the output circuitry, including its power supply, it is necessary that the output POLARITY SWITCH be on "OFF" or "NEG". The unit may be permanently damaged otherwise.

a) Set REPETITION RATE to .1 mc/s.

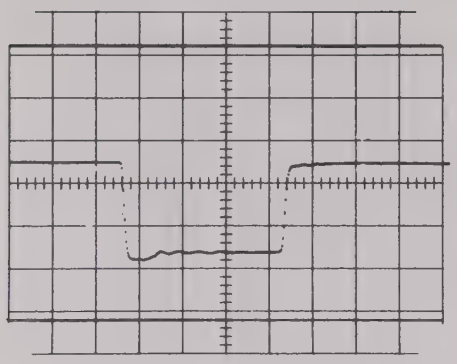
b) Set PULSE DELAY to .1 μsec.

c) Set PULSE WIDTH to .5 μsec.

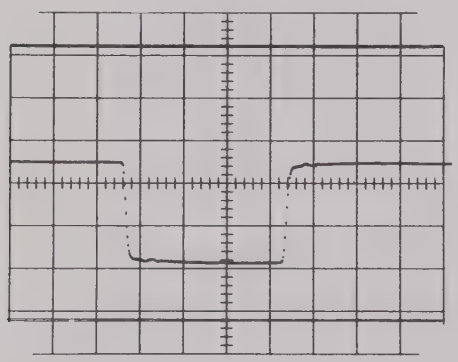
d) Sync oscilloscope from sync output. Set sweep speed to .1 μsec/cm and view the neg. output pulse terminated into 50 ohms.

e) Adjust R426 (-15V adj.) CCW until it is apparent that the pulse top drops just below the clamp level. Now back the control off until the pulse top is slightly past clamp. (See Fig. 4-4).

Figure 4-4



A. Pulse top below clamp level, turn -15 adj. pot CW to obtain B



B. Proper pulse top adjustment

4.4.8 Duty Cycle Overload Calibration

a) Set REPETITION RATE to 1 kc/s, VERNIER CCW.

b) Set PULSE DELAY to 0.

c) Set PULSE WIDTH to 5 Millisec., VERNIER CCW.

d) Set PULSE POLARITY to Pos.

e) Set $-V_{cc}$ OV'L'D ADJ to fully CW.

f) Set AMPLITUDE at 5.0v.

g) View pulse output on general purpose, DC oscilloscope with calibrated sweep.

h) Set PULSE WIDTH to 2 millisec. & adjust REPETITION RATE for a square wave output (50% duty cycle).

i) Rotate $-V_{cc}$ OV'L'D ADJ CCW until pulse top begins to have some distortion, then rotate $-V_{cc}$ OV'L'D ADJ in the opposite direction until the distortion just disappears.

This completes calibration adjustment procedure for the DATAPULSE Model 108 pulse generator.

4.5 SPECIFICATIONS VERIFICATION

The following detailed test was performed on this instrument, just prior to shipment, to confirm published specifications. Before the test was conducted, the instrument was aged for a 24 hour period, and had undergone rigid examination for workmanship and appearance.

This test should be performed after every 200 hours of operation to confirm calibration status. Recalibrate and/or troubleshoot the instrument if the specifications are not verifiable.

4.5.1 Equipment Required

a) Oscilloscope, a general purpose oscilloscope of at least 30 mc band-pass with either delayed sweep or high sweep magnification. Hewlett-Packard 175A or Tektronix 543 is adequate.

b) Oscilloscope, Hewlett-Packard 185B, Tektronix 661, or equivalent (high band pass).

c) 50 ohm termination, Datapulse 2002A.

d) 30 db coaxial attenuator, greater than 300 mc band pass.

e) Trigger generator (10 mc).

f) Variable line auto transformer such as Powerstat Series 20.

4.5.2 Repetition Rate

4.5.2.1 Oscillator Timing:

a) Set PULSE DELAY to 0.05 μs, VERNIER ccw.

b) Set PULSE WIDTH to 0.05 μs, VERNIER ccw.

c) Set Attenuators to 50V, VERNIER cw.

d) Terminate outputs into 50Ω load.

e) Sync scope from sync output.

f) View Neg. output pulse with general purpose scope and follow the panel control settings in Table 4-7.

TABLE 4-7
REPETITION RATE CALIBRATION VERIFICATION

Rep. Rate Range	Vernier Position	Pulse Width	Sweep Speed (per cm)	Pulse Spacing	Tolerance
0.1kc	ccw	5 ms	100 ms	100ms (10cps)	Absolute
0.1kc	cw	.5ms	10 ms	10ms (0.1kc)	±5%
1 kc	ccw	.5ms	10 ms	10ms (0.1kc)	Absolute
1 kc	cw	50μs	1 ms	1ms (1 kc)	±5%
10 kc	ccw	50μs	1 ms	1ms (1 kc)	Absolute
10 kc	cw	5 μs	100 μs	.1ms (10 kc)	±5%
0.1mc	ccw	5 μs	100 μs	.1ms (10 kc)	Absolute
0.1mc	cw	.5μs	10 μs	10μs (.1mc)	±5%
1 mc	ccw	.5μs	10 μs	10μs (.1mc)	Absolute
1 mc	cw	50ns	1 μs	1 μs (1mc)	±5%
10 mc	ccw	50ns	1 μs	1 μs (1mc)	±5%
10 mc	cw	50ns	.1 μs	.1 μs (10mc)	±5%

4.5.2.2 Jitter:

a) Set controls as in 4.5.2.1 (a thru f) above.

b) Set REPETITION RATE to 10 mc, VERNIER fully cw.

c) Set Sweep Speed to 0.1 μs/cm.

d) View pos. output pulse terminated into 50Ω load. One pulse should appear for each cm. View the 10th pulse and expand sweep to 10 ns/cm. The jitter should be less than 0.1 cm, (0.1%).

4.5.2.3 Stability: Leave setup as in paragraph 4.5.2.2. Vary input voltage from 105v ac to 125v ac. The shift should be less than 0.2cm (2%).

4.5.2.4 External Triggering: Apply a ±5v signal from trigger generator to the external trigger input jack and verify that instrument can be slaved up to 10 mc with repetition rate control in both Ext. + and Ext. - positions.

4.5.2.5 Sync Pulse:

a) Set DELAY and WIDTH to minimum.

b) Set SYNC POLARITY to POS.

c) Set SYNC VOLTS cw.

d) View sync pulse output into a 50Ω load (2002A or equivalent).

e) Sync pulse amplitude should not drop below 6V when REPETITION RATE is varied from 1 mc to 10 mc.

f) Set SYNC POLARITY to NEG.

g) Verify sync pulse amplitude of 6V or more.

h) Set SYNC VOLTS ccw.

i) Verify sync pulse amplitude of approximately 0.25 volts.

4.5.2.6 External Gate Input:

a) View output pulse.

b) Verify that the output pulse does not occur upon application of minus six (-6) volts dc to the GATE INPUT connector.

4.5.3 Pulse Delay

4.5.3.1 Delay Timing:

a) Set Pos. and Neg. ATTENUATORS to 10v, VERNIERS cw.

b) Set RISE TIME to min. (ccw).

c) Set REPETITION RATE to 0.1 mc, VERNIER cw.

d) Sync oscilloscope from sync output.

e) View the sync pulse and positive pulse output (50Ω termination) simultaneously on dual trace oscilloscope.

f) Follow control settings in Table 4-8.

4.5.3.2 Delay Duty Cycle:

a) Set REPETITION RATE to 0.1 mc, VERNIER cw.

b) Set PULSE WIDTH to 0.05 μs, VERNIER cw.

c) Sync scope from positive sync output with sweep speed of 1μs/cm.

d) View positive pulse output (50Ω termination).

e) Set DELAY to 0.5μs, VERNIER ccw. Slowly turn VERNIER cw and verify that 50% delay duty cycle (5μs) can be attained without circuit failure.

4.5.3.3 Delay Jitter:

a) With controls set as in paragraph 4.5.3.2, (5μs delay). Set sweep speed to 0.5μs/cm and expand to 50 ns/cm.

b) View leading edge of pulse and verify that jitter is less than 0.1cm (0.1%).

4.5.3.4 Delay Stability: With same setup as paragraph 4.5.3.3, vary input voltage from 105 v to 125 v and verify that delay change is less than 0.2cm (2%).

TABLE 4-8
DELAY CALIBRATION VERIFICATION

Delay Range	Vernier Position	Pulse Width	Rep. Rate	Sweep Speed (per cm)	Delay	Tolerance
0.05μs	ccw	50ns	0.1mc	20ns	0ns	Approx.
0.05μs	cw	50ns	0.1mc	50ns	0.5μs (10cm)	±0.5cm
0.5μs	ccw	0.5μs	10kc	50ns	0.5μs (10cm)	±0.5cm
0.5μs	cw	0.5μs	10kc	.5μs	5μs (10cm)	±0.5cm
5μs	ccw	5μs	1kc	.5μs	5μs (10cm)	±0.5cm
5μs	cw	5μs	1kc	5μs	50μs (10cm)	±0.5cm
0.05ms	ccw	0.05ms	0.1kc	5μs	50μs (10cm)	±0.5cm
0.05ms	cw	0.05ms	0.1kc	50μs	0.5ms (10cm)	±0.5cm
0.5ms	ccw	0.5ms	0.1kc	50μs	0.5ms (10cm)	±0.5cm
0.5ms	cw	0.5ms	10cps	.5ms	5ms (10cm)	±0.5cm

4.5.4 Pulse Width

4.5.4.1 Pulse Width Timing:

a) Set ATTENUATORS to 10 v, VERNIERS cw.

b) Set RISE TIME ccw.

c) Set REPETITION RATE to 0.1 mc, VERNIER cw.

d) Sync Oscilloscope from sync output.

e) View the positive pulse output (50Ω termination).

f) Follow control settings on Table 4-9.

TABLE 4-9
WIDTH CALIBRATION VERIFICATION

Width Range	Vernier Position	Pulse Delay	Rep. Rate	Sweep Speed (per cm)	Tolerance	Width
0.05μs	ccw	50ns	0.1mc	20ns	Absolute	20ns (1cm)
0.05μs	cw	50ns	0.1mc	50ns	±0.5cm	0.5μs (10cm)
0.5μs	ccw	0.5μs	10kc	50ns	±0.5cm	0.5μs (10cm)
0.5μs	cw	0.5μs	10kc	.5μs	±0.5cm	5μs (10cm)
5μs	ccw	5μs	1kc	.5μs	±0.5cm	5μs (10cm)
5μs	cw	5μs	1kc	5μs	±0.5cm	50μs (10cm)
0.05ms	ccw	0.05ms	0.1kc	5μs	±0.5cm	50μs (10cm)
0.05ms	cw	0.05ms	0.1kc	50μs	±0.5cm	0.5ms (10cm)
0.5ms	ccw	0.5ms	0.1kc	50μs	±0.5cm	0.5ms (10cm)
0.5ms	cw	0.5ms	10cps	.5ms	±0.5cm	5ms

4.5.4.4 Pulse Width Stability: With the same set-up as paragraph 4.5.3.3, vary line voltage from 150 v to 125 v and verify that pulse width change is less than 0.2cm (2%).

4.5.4.2 Pulse Width Duty Cycle:

a) Set REPETITION RATE to 0.1 mc, VERNIER cw.

b) Set PULSE DELAY to 0.05μs, VERNIER cw.

c) Sync scope from positive sync output with sweep speed of 1μs/cm.

d) View positive pulse output (50Ω termination).

e) Set PULSE WIDTH to 0.5μs, VERNIER ccw. Slowly turn VERNIER cw and verify that 50% WIDTH duty cycle (5μs) can be attained without circuit failure.

4.5.4.3 Pulse Width Jitter:

a) With controls set as in paragraph 4.5.4.2, (5μs Pulse Width). Set sweep speed to 0.5μs/cm and expand to 50 ns/cm.

b) View lagging edge of pulse and verify that jitter is less than 0.1 cm (0.1%).

4.5.5 Main Pulse Output

4.5.5.1 Transition Time: (See Fig. 4-5 for proper scope interconnections. Note: Check to make certain that the scope smoothing controls are not limiting its bandpass).

a) Set REPETITION RATE to .1mc/s, VERNIER cw.

b) Set PULSE DELAY to .05μsec, VERNIER approx. 10% rotated cw from full ccw position.

c) Set PULSE WIDTH to .05μsec, VERNIER approx. 10% rotated cw from full ccw position (.1μsec pulse width).

d) Set PULSE AMPLITUDE at 50 volts, VERNIER at cw (X1).

e) Set RISE TIME at MIN.

f) Set PULSE POLARITY on POS.

g) View the Pulse leading edge on the Sampling Scope and verify that transition time is less than 7 nanosec. from its 10% to 90% amplitude points.

h) View the pulse trailing edge on the sampling scope and verify that the transition time is less than 7 nanosec. from its 10% to 90% amplitude points.

i) Set PULSE POLARITY on NEG.

j) Repeat steps (g) and (h) above.

4.5.5.2 Wave Shape: (See Fig. 4-5 for proper scope interconnections).

a) Set REPETITION RATE to .1mc/s, VERNIER ccw.

b) Set PULSE DELAY to .05μsec., VERNIER approx. 10% rotated cw from full ccw position.

c) Set PULSE WIDTH to .05μsec., VERNIER cw.

d) Set RISE TIME at MIN.

e) Set AMPLITUDE at 50V, VERNIER X1.

f) Set overall Scope Sensitivity (attenuation of coaxial attenuators plus scope) to 2 volts per cm.

g) View the Positive Output Pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1 cm in amplitude. (4%).

h) View the Negative Output Pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1 cm in amplitude. (4%).

i) Set AMPLITUDE at 5.0V, VERNIER X1.

j) Set Scope Sensitivity to 200 millivolts per cm.

k) View the Positive Output Pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1 cm in amplitude. (4%).

l) View the Negative Output Pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1 cm in amplitude. (4%).

m) Set AMPLITUDE at .20V, VERNIER X1.

n) Set Scope Sensitivity to 10 mv/cm.

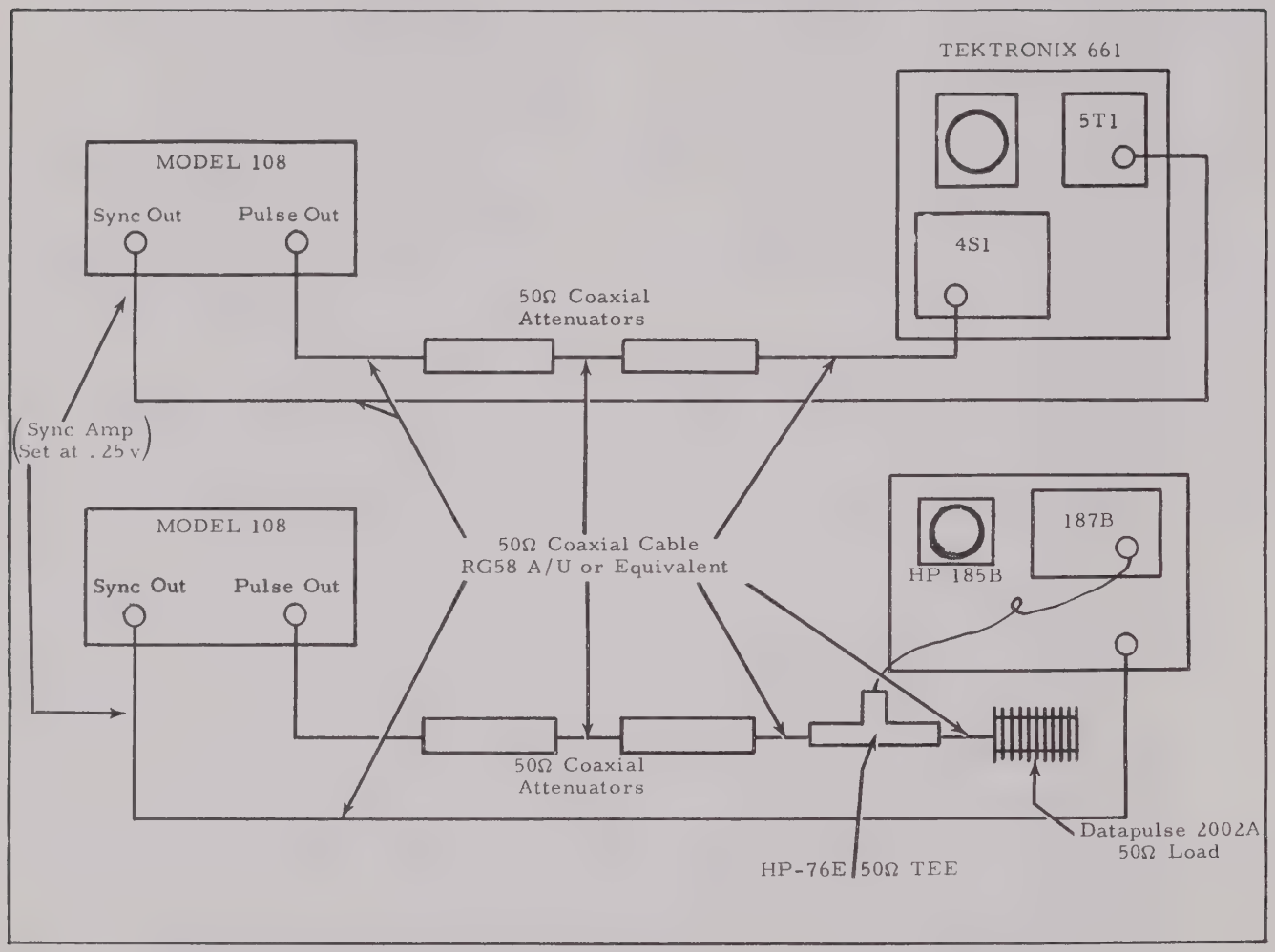
o) View the positive output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1.2 cm in amplitude. (7%).

p) View the negative output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1.2 cm in amplitude. (7%).

q) Set the Scope Sensitivity to 200 mv per cm.

r) Rotate the RISE TIME control cw and verify that the pulse transition times increase to nearly 50 nanoseconds.

Figure 4-5
Scope Interconnections for Waveform Verification



PARTS LIST

5.1 HOW TO USE THIS PARTS LIST

5.1.1 Reference Designations

Reference designations used throughout this listing correspond with reference designations given on component location photos and the following schematics:

Drawing No. 41000-024
Drawing No. 40000-052
Drawing No. 40000-053
Drawing No. 40000-055
Drawing No. 40000-056
Drawing No. 40000-057

Resistors are designated as R1, R2, R3, etc., and are fixed value, composition, 10% and 1/2w unless otherwise noted.

Capacitors are designated as C1, C2, C3, etc., and are fixed value, 10%, 500v dc unless otherwise noted.

Diodes are designated as CR1, CR2, CR3; switches as S1, S2, S3; inductors as L1, L2, and L3, etc.

5.1.2 Abbreviations

The following abbreviations are used:

CER	- Ceramic
DPC	- Deposited Carbon
ELECT	- Electrolytic
M	- Mica
MP	- Metalized Paper
GMV	- Guaranteed Min. Value
OF	- Oil Filled
PT	- Paper Tubular
SM	- Silver Mica
VAR	- Variable
WW	- Wire Wound
VTQ	- Vitamin Q
PNP	- Positive-Negative-Positive
NPN	- Negative-Positive-Negative
μsec	- Microsecond
μf	- Microfarad
μh	- Microhenry
ns	- Nanosecond
ms	- Millisecond

5.1.3 Federal Manufacturers Code Numbers

Manufacturers of the components used in this instrument are referenced herein by Federal Supply Code numbers as given in the October 1959 issue of Department of Defense Cataloging Handbook H4-1 and H4-2, available from the Armed Forces Supply Support Center, Washington, D. C.

5.2 RESISTORS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R1	3	560Ω, 5%	10011-561	01121	EB5615		
R2	1	430Ω, 5%	10011-431	01121	EB4315		
R3	10	1.5k, 5%	10011-152	01121	EB1525		
R4	6	390Ω, 5%	10011-391	01121	EB3915		
R5	23	1k, 5%	10011-102	01121	EB1025		
R6	1	750Ω, 5%	10011-751	01121	EB7515		
R7	3	820Ω, 5%	10011-821	01121	EB8215		
R8	1	10Ω, 5%	10011-100	01121	EB1005		
R9	5	47Ω, 5%	10011-470	01121	EB4705		
R10		Same as R3					
R11	7	2.7k, 5%	10011-272	01121	EB2725		
R12		Same as R7					
R13	17	470Ω, 5%	10011-471	01121	EB4715		
R14	1	3.9k, 5%	10011-392	01121	EB3925		
R15		Same as R5					
R16		Same as R13					
R17	11	100Ω, 5%	10011-101	01121	EB1015		
R18		Same as R11					
R19	24	10k, 5%	10011-103	01121	EB1035		
R20	8	100k, 5%	10011-104	01121	EB1045		
R21		Same as R13					
R22 thru R32		Not Used					
R33	4	15k, 5%	10011-153	01121	EB1535		
R34		Not Used					
R35	8	4.7k, 5%	10011-472	01121	EB4725		
R36		Not Used					
R37		Same as R17					
R38		Not Used					
R39		Not Used					
R40		Not Used					
R41	3	22k, 5%	10011-223	01121	EB2235		
R42		Same as R9					
R43		Same as R9					
R44		Same as R13					
R45		Same as R1					
R46	4	200Ω, 5%	10011-201	01121	EB2015		
R47		Same as R13					
R48		Same as R5					
R49	22	22Ω, 5%	10011-220	01121	EB2205		
R50		Same as R46					
R51		Same as R11					
R52		Same as R20					
R53		Same as R4					
R54	4	220Ω, 5%	10011-221	01121	EB2215		
R55		Same as R5					
R56		Same as R19					
R57		Same as R17					
R58		Same as R5					
R59		Same as R5					
R60	6	47k, 5%	10011-473	01121	EB4735		
R61		Same as R49					
R62	1	50Ω, Var. Comp. Dual Gauged	20213-500S	01121	AB Type JJ		
R63	1	51Ω, 2W, 5% Met. Film	10723-510	07115	Corning C42		
R64	1	51Ω, 5%	10011-510	07115	EB5105		
R65		Same as R5					
R66		Same as R46					
R67		Same as R9					
R68		Not Used					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R69	6	180Ω, 5%	10011-181	01121	EB1815		
R70	7	27k, 5%	10011-273	01121	EB2735		
R71		Same as R33					
R72	2	3k, 5%	10011-302	01121	EB3025		
R73		Same as R49					
R74		Same as R17					
R75		Same as R3					
R76		Same as R17					
R77		Same as R3					
R78		Same as R49					
R79		Same as R70					
R80	2	1.2k, 1w, 5%	10012-122	01121	GB1225		
R81	5	680Ω, 5%	10011-681	01121	EB6815		
R82	4	330Ω, 5%	10011-331	01121	EB3315		
R83		Same as R17					
R84	1	1.8k, 5%	10011-182	01121	EB1825		
R85		Same as R13					
R86		Same as R13					
R87		Same as R49					
R88		Same as R54					
R89		Same as R9					
R90		Same as R11					
R91		Same as R4					
R92		Same as R5					
R93		Same as R81					
R94		Same as R60					
R95 thru R100		Not Used					
R101		Same as R69					
R102		Same as R13					
R103		Same as R49					
R104		Same as R11					
R105		Same as R4					
R106		Same as R69					
R107		Same as R3					
R108	1	1.2k, 5%	10011-122	01121	EB1225		
R109		Same as R82					
R110		Same as R19					
R111		Same as R5					
R112		Same as R19					
R113		Same as R20					
R114		Same as R54					
R115		Same as R35					
R116		Same as R20					
R117		Same as R5					
R118		Same as R5					
R119		Same as R70					
R120		Same as R33					
R121		Same as R5					
R122		Same as R19					
R123		Same as R19					
R124		Same as R20					
R125		Same as R5					
R126		Same as R35					
R127		Same as R20					
R128		Same as R19					
R129		Same as R41					
R130		Same as R13					
R131		Same as R5					
R132		Same as R13					
R133		Same as R60					
R134 thru R139		Not Used					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R140		Same as R70					
R141		Same as R33					
R142		Same as R72					
R143		Same as R54					
R144		Same as R17					
R145 thru R150		Not Used					
R151		Same as R60					
R152		Same as R81					
R153		Same as R69					
R154		Same as R17					
R155		Same as R13					
R156		Same as R49					
R157		Same as R69					
R158		Same as R3					
R159		Same as R11					
R160		Same as R4					
R161		Same as R49					
R162		Same as R70					
R163		Same as R80					
R164		Same as R69					
R165 thru R200		Not Used					
R201	8	12Ω, 2w, 5% Fxd. Met. Film.	10723-120	07115	Corning Type C42		
R202	8	11Ω, 2w, 5% Fxd. Met. Film.	10723-110	07115	Corning Type C42		
R203	4	22Ω, 5w, 5% Fxd. Met. Film.	10764-221	07115	Corning LP1-5		
R204		Same as R201					
R205		Same as R202					
R206		Same as R201					
R207		Same as R202					
R208		Same as R203					
R209		Same as R201					
R210		Same as R202					
R211		Same as R201					
R212		Same as R202					
R213		Same as R203					
R214		Same as R201					
R215		Same as R202					
R216		Same as R201					
R217		Same as R202					
R218		Same as R203					
R219		Same as R201					
R220		Same as R202					
R221		Same as R17					
R222 thru R230		Not Used					
R231	5	130Ω, 3w, 5%	10754-131	07115	Corning Type LPI-3		
R232 thru R235		Same as R231					
R236	4	36Ω, 3w, 5%	10754-360	07115	Corning LPI-3		

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R237		Same as R236					
R238	3	75Ω, 3w, 5%	10754-750	07115	Corning LPI-3		
R239		Same as R238					
R240		Same as R238					
R241		Same as R236					
R242		Same as R236					
R243	6	27Ω, 2w, 5%	10013-270	01121	HB2705		
R244	3	36Ω, 2w, 5%	10013-360	01121	HB3605		
R245		Same as R243					
R246		Same as R243					
R247		Same as R244					
R248		Same as R243					
R249		Same as R243					
R250		Same as R244					
R251		Same as R243					
R252 thru R300		Not Used					
R301	2	120Ω, 5%	10011-121	01121	EB1215		
R302		Same as R70					
R303		Same as R20					
R304	2	1.5k, 1w, 5%	10012-152	01121	GB1525		
R305		Same as R3					
R306		Same as R3					
R307		Same as R20					
R308		Same as R70					
R309		Same as R301					
R310		Same as R304					
R311		Same as R17					
R312	1	680Ω, 2w, 5%	10013-681	01121	HB6815		
R313		Same as R13					
R314		Same as R19					
R315	1	470Ω, 2w, 5%	10013-471	01121	HB4715		
R316	1	1k, 2w	20053-102	01121	JAIN 056S1024A		
R317		Not Used					
R318		Not Used					
R319		Not Used					
R320		Same as R46					
R321	1	5.1k, 5%	10011-512	01121	EB5125		
R322		Same as R35					
R323		Same as R5					
R324	1	15Ω, 5%	10011-150	01121	EB1505		
R325		Same as R13					
R326 thru R329		Not Used					
R330		Same as R311					
R331	1	510Ω, 5%	10011-511	01121	EB5115		
R332	7	2.2k, 5%	10011-222	01121	EB2225		
R333		Same as R60					
R334		Same as R5					
R335		Same as R5					
R336		Not Used					
R337		Same as R332					
R338		Same as R35					
R339		Same as R42					
R340		Same as R5					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R341		Same as R332					
R342		Same as R19					
R343	1	2k, 1w, 5%	10012-202	01121	GB2025		
R344		Not Used					
R345		Same as R1					
R346 thru R349		Not Used					
R350 thru R353		Same as R49					
R354 thru R359		Same as R19					
R360		Same as R49					
R361		Same as R49					
R362		Same as R5					
R363		Same as R49					
R364		Same as R49					
R365 thru R368		Same as R19					
R369		Not Used					
R370 thru R375		Same as R49					
R376	6	2.7k, 2w, 5%	10013-272	01121	HB2725		
R377 thru R381		Same as R376					
R382	6	27Ω, 5%	10011-270	01121	EB2705		
R383 thru R387		Same as R382					
R388		Same as R13					
R389	1	1k, 2w, 5%	10013-102	01121	HB1025		
R390 thru R399		Not Used					
R400	1	1k, 1w	10022-102	01121	GB1021		
R401		Same as R60					
R402	2	2.7Ω, 1w	10022-279	01121	GB2791		
R403		Same as R402					
R404	3	500Ω, 2w, 20%, VAP WW	10493-501	01121	MEL-RAIN HHH-2		
R405		Same as R19					
R406	2	4.3k, 5%	10011-432	01121	EB4325		
R407	1	1k, 2w, Vari Comp	20053-102	01121	JAIN 056 102UA		
R408	2	1k, .2w, 30%, P.C. Mtg.	20240-102	71121	UPE 70		
R409		Same as R406					
R410 thru R419		Not Used					
R420		Same as R11					
R421	1	10Ω, 1w	10022-100	01121	GB1001		
R422		Same as R19					
R423	1	10k, .2w, 30%, PC Mtg.	20240-103	71450	UPE 70		
R424		Same as R19					
R425		Same as R108					
R426		Same as R404					
R427	2	270Ω, 5%	10011-271	01121	EB2715		
R428		Same as R427					
R429		Same as R404					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R430		Same as R332					
R431		Same as R35					
R432	1	470Ω, 1w	10022-471	01121	GB4711		
R433 thru R439		Not Used					
R440	1	Same as R4					
R441		Same as R7					
R442		Same as R408					
R443		Same as R332					
R444		Same as R13					
R445 thru R500		Not Used					
R501	1	33k, 5%	10011-333	01121	EB3335		
R502 thru R509		Not Used					
R510	2	5Ω, 5w, 5%	10304-509	06136	SF5WL		
R511	2	200Ω, 5w, 5%	10304-201	06136	SF200WL		
R512		Same as R81					
R513		Same as R19					
R514		Same as R35					
R515		Same as R5					
R516		Same as R408					
R517		Same as R13					
R518		Not Used					
R519		Not Used					
R520		Not Used					
R521		Same as R332					
R522		Same as R408					
R523		Same as R82					
R524		Same as R5					
R525		Same as R1					
R526		Same as R3					
R527	2	100Ω, 10w, 5%	10305-101	06136	10F100WL		
R528		Not Used					
R529		Not Used					
R530		Same as R511					
R531		Same as R510					
R532		Same as R81					
R533		Same as R19					
R534		Same as R35					
R535		Same as R13					
R536		Same as R408					
R537		Same as R5					
R538		Same as R332					
R539		Same as R408					
R540		Same as R82					
R541		Same as R5					
R542		Same as R1					
R543		Same as R3					
R544	1	47Ω, 2w, 5%	10013-470	01121	HB4705		
R545		Same as R527					
R546	1	18Ω, 1w, 5%	10012-180	01121	GB1805		

5.3 CAPACITORS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C1	36	.1μf, 75v, Ceramic Disc	11242-104	71590	DDA-104		
C2		Same as C1					
C3		Same as C1					
C4	2	4-30pf, Var. Ceramic	11307-300	91674	503-000		
C5 thru C9		Not Used					
C10	6	27pf, 5%, S.M.	11017-270	00853	RR1427		
C11		Same as C1					
C12	1	39pf, 5%, S.M.	11017-39	00853			
C13		Not Used					
C14		Same as C10					
C15		Same as C1					
C16	8	100μf, 35v, Elect. P.C. Mtg.	11162-107	Nashville	20-500-DP100-35585		
C17	2	1μf, 50v, Elect.	11152-105	MEC, Inc.	EG8-1-50P		
C18		Same as C1					
C19	2	470pf, 300v, 5%, S.M.	11015-471	00853	RR06347		
C20	1	1μf, 100v, Mylar	11083-105	09023	WMF1W1		
C21 thru C39		Not Used					
C40		Same as C1					
C41		Same as C19					
C42		Same as C1					
C43		Same as C1					
C44	6	47pf, 5%, S.M.	11017-470	00853	RR1447		
C45	9	100pf, 5%, S.M.	11017-101	00853	RR1310		
C46		Same as C1					
C47		Same as C1					
C48		Same as C45					
C49		Same as C44					
C50		Same as C1					
C51		Same as C1					
C52 thru C69		Not Used					
C70		Same as C45					
C71		Same as C1					
C72		Same as C16					
C73		Same as C1					
C74		Same as C1					
C75		Same as C1					
C76 thru C80		Not Used					
C81		Same as C1					
C82		Same as C1					
C83		Same as C16					
C84		Same as C1					
C85		Same as C44					
C86		Same as C1					
C87		Same as C1					
C88		Same as C1					
C89		Same as C45					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C90		Same as C1					
C91		Same as C45					
C92 thru C100		Not Used					
C101		Same as C1					
C102	3	100μf, 12v, Elect.	11151-107	09023	NLW100-12		
C103		Same as C45					
C104		Same as C44					
C105		Same as C102					
C106		Same as C45					
C107		Same as C44					
C108		Same as C1					
C109		Same as C1					
C110 thru C139		Not Used					
C140		Same as C45					
C141 thru C144		Same as C1					
C145		Same as C45					
C146		Same as C1					
C147		Same as C16					
C148		Same as C1					
C149	1	4000μf, 10v, TABS	11170-408	09023	1040FB		
C150 thru C200		Not Used					
C201		Same as C4					
C202 to C300		Not Used					
C301		Same as C1					
C302		Same as C10					
C303		Same as C301					
C304		Same as C301					
C305		Same as C10					
C306		Same as C301					
C307		Same as C301					
C308	1	150pf, 5%, S.M.	11017-151	00853	RR1315		
C309		Same as C301					
C310	4	100μf, 35v, Elect.	11159-107	Nashville	22-500 BP100-35D85		
C311		Same as C301					

PARTS LIST

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C312 thru C319		Not Used					
C320		Same as C44					
C321	1	33pf, 5%, S. M.	11017-330	00853	RR1433		
C322 thru C329		Not Used					
C330		Same as C301					
C331		Same as C301					
C332		Same as C10					
C333		Same as C301					
C334		Same as C301					
C335		Same as C301					
C336	7	220pf, 5%, S. M.	11017-221	00853	RR1322		
C337		Same as C10					
C338	3	10μf, 100v, Elect.					
C339	1	20μf, 50v, Elect.	11152-206	56289	TE1305		
C340		Same as C301					
C341		Same as C301					
C342 thru C349		Not Used					
C350 thru C354		Same as C301					
C355		Not Used					
C356		Not Used					
C357 thru C362		Same as C301					
C363		Same as C338					
C364		Same as C301					
C365 thru C369		Not Used					
C370		Same as C301					
C371		Same as C338					
C372 thru C376		Same as C301					
C377 thru C382		Same as C336					
C382 thru C390		Same as C301					
C391		Same as C102					
C392		Same as C301					
C393 thru C399		Not Used					
C400	2	300μf, 150v, Elect.	11153-307	56289	TVA1425		
C401		Same as C400					
C402	2	4000μf, 3v, Elect.	11160-408	MEC Inc.	BST30-40-3P		
C403		Same as C402					
C404		Same as C17					
C405 thru C419		Not Used					
C420	3	10μf, 100v, Elect.	11153-106	56289	TE1407		
C421		Same as C420					
C422 thru C439		Not Used					
C440	2	500μf, 50v, Elect.	11152-507	56289	TVA1315		
C441		Same as C440					
C442		Not Used					
C443		Same as C310					
C444		Same as C420					
C445 thru C500		Not Used					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C501	2	.1μf, 400v, Mylar	11066-104	56289	4DP-1-103		
C502		Same as C501					
C503 thru C509		Not Used					
C510	2	1250μf, 50v, Elect.	11162-158	00853	PLP1500-50VE		
C511		Same as C16					
C512		Same as C16					
C513		Not Used					
C514		Not Used					
C515		Same as C1					
C516 thru C529		Not Used					
C530		Same as C510					
C531		Same as C16					
C532		Same as C16					
C533		Not Used					
C534		Not Used					
C535		Same as C1					

5.4 TRANSISTORS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
Q1	4	Silicon, PNP	22595-000	73293	DP59-0		
Q2	37	Silicon, NPN	22635-000	94990	DP63-0		
Q3		Same as Q2					
Q4		Same as Q2					
Q5		Same as Q2					
Q6		Same as Q2					
Q7	3	Germ., PNP	22465-000	93332	DP46-0		
Q8		Same as Q2					
Q9		Same as Q2					
Q10		Same as Q2					
Q11		Same as Q7					
Q12		Same as Q7					
Q13	6	Silicon, NPN	12685-004	94990	SM1330		
Q14		Same as Q13					
Q15 thru Q21		Same as Q2					
Q22		Not Used					
Q23		Not Used					
Q24 thru Q26		Same as Q2					
Q27 thru Q32		Not Used					
Q33		Same as Q13					
Q34		Not Used					
Q35		Not Used					
Q36 thru Q42		Same as Q2					
Q43 thru Q300		Not Used					
Q301	7	Germ., PNP	22465-000	93332	DP46-0		
Q302		Same as Q301					
Q303	7	Silicon, NPN	22635-000	94990	DP63-0		
Q304	5	Silicon, PNP	22605-001	94990	DP60-1		
Q305		Not Used					
Q306		Same as Q303					
Q307		Same as Q303					
Q308 thru Q311		Same as Q301					
Q312	1	Silicon, NPN	12685-004	94990	SM1330		
Q313		Same as Q301					
Q314		Same as Q303					
Q315		Same as Q304					
Q316		Same as Q303					
Q317		Same as Q304					
Q318		Same as Q303					
Q319		Same as Q304					
Q320	1	Silicon, PNP	22595-000	73293	DP59-0		
Q321		Same as Q303					
Q322		Same as Q304					
Q323	6	Silicon, PNP	22605-002	94990	DP602		
Q324 thru Q328		Same as Q323					
Q329	6	Silicon, NPN	22635-001	94990	DP63-1		
Q330 thru Q334		Same as Q329					
Q335 thru Q399		Not Used					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
Q400	1	NPN Silicon	12676-003	93539	W152-09		
Q401	3	NPN Silicon	12695-001	02735	2N2270		
Q402	1	NPN Germanium	12505-001	01295	2N1302		
Q403		Same as Q401					
Q404 thru Q419		Not Used					
Q420	2	PNP Germanium	12455-002	94990	2N1540		
Q421	1	PNP Silicon	12595-002	07263	2N1991		
Q422		Same as Q401					
Q423	1	NPN Silicon	12685-004	94990	SM1330		
Q424 thru Q439		Not Used					
Q440		Same as Q420					
Q441	1	PNP Silicon	22595-000	73293	DP59-0		
Q442 thru Q500		Not Used					
Q501		Same as Q1					
Q502		Same as Q13					
Q503	2	PNP Germanium	12455-007	94990	2N669		
Q504		Not Used					
Q505		Same as Q2					
Q506	1	Germanium, PNP	12455-007	94990	2N669		
Q507		Not Used					
Q508		Same as Q503					
Q509		Same as Q13					
Q510		Same as Q1					
Q511		Same as Q1					
Q512		Same as Q13					

5.5 DIODES

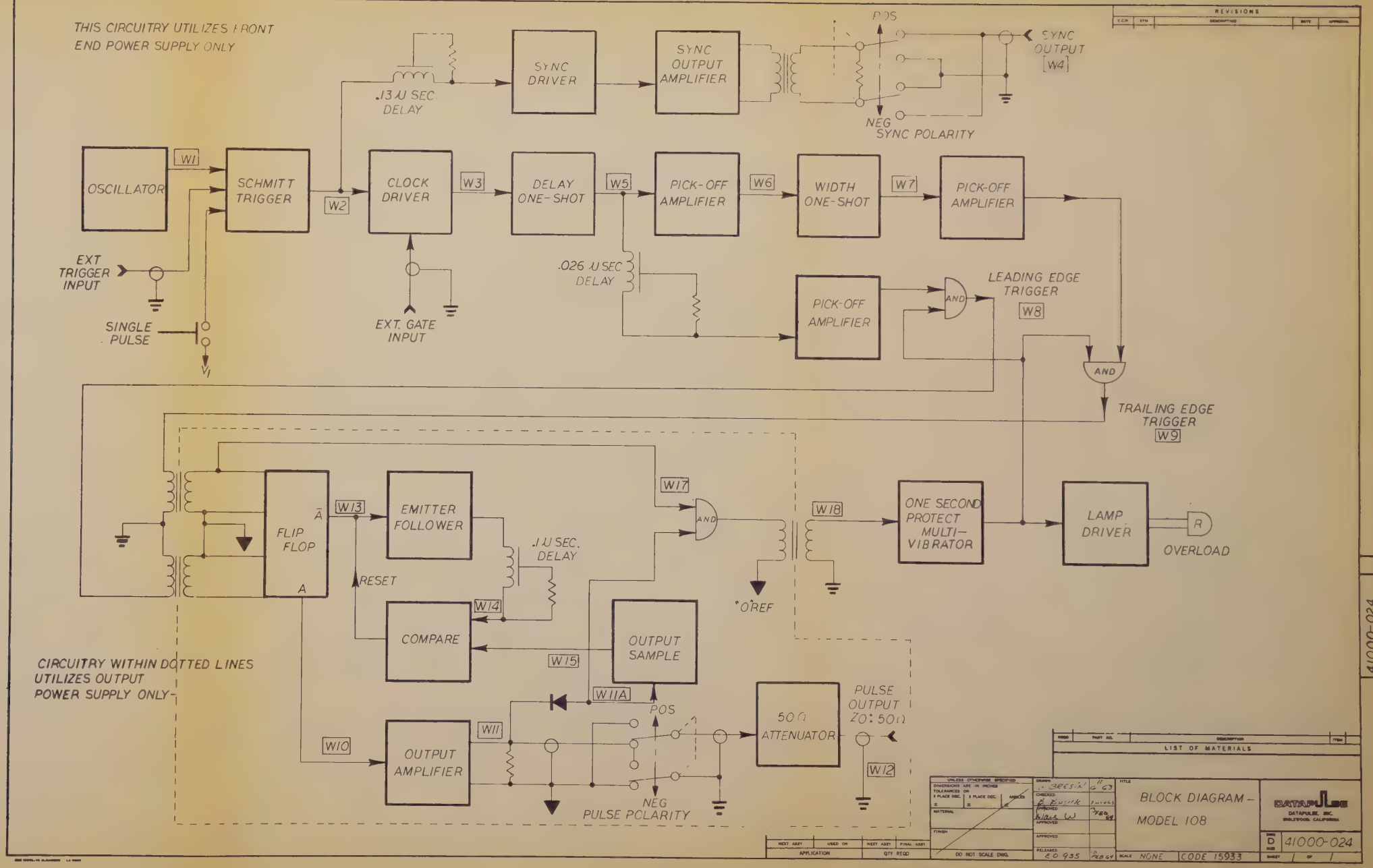
REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
CR1	3	Germanium, 15v	12144-003	93332	1N995		
CR2	2	Germanium, 45v	12144-002	06961	CTP462		
CR3		Same as CR2					
CR4	27	Silicon, 40v	22164-000	03508	DP16-0		
CR5		Same as CR4					
CR6		Same as CR4					
CR7 thru CR40		Not Used					
CR41 thru CR46		Same as CR4					
CR47 thru CR69		Not Used					
CR70		Same as CR4					
CR71		Same as CR4					
CR72	2	Rectifier, Sil. 400v, Axial Lead	22194-000	Computer Prod.	DP19-0		
CR73		Same as CR4					
CR74		Same as CR1					
CR75		Same as CR4					
CR76		Same as CR4					
CR77		Same as CR4					
CR78		Not Used					
CR79		Not Used					
CR80		Same as CR4					
CR81		Same as CR4					
CR82 thru CR100		Not Used					
CR101 thru CR104		Same as CR4					
CR105 thru CR139		Not Used					
CR140		Same as CR4					
CR141		Same as CR4					
CR142		Same as CR72					
CR143		Same as CR4					
CR144		Same as CR1					
CR145		Same as CR4					
CR146		Same as CR4					
CR147		Same as CR4					
CR148 thru CR300		Not Used					
CR301	27	Silicon, Axial Leads	22164-000	03508	DP16-0		
CR302		Same as CR301					
CR303		Same as CR301					

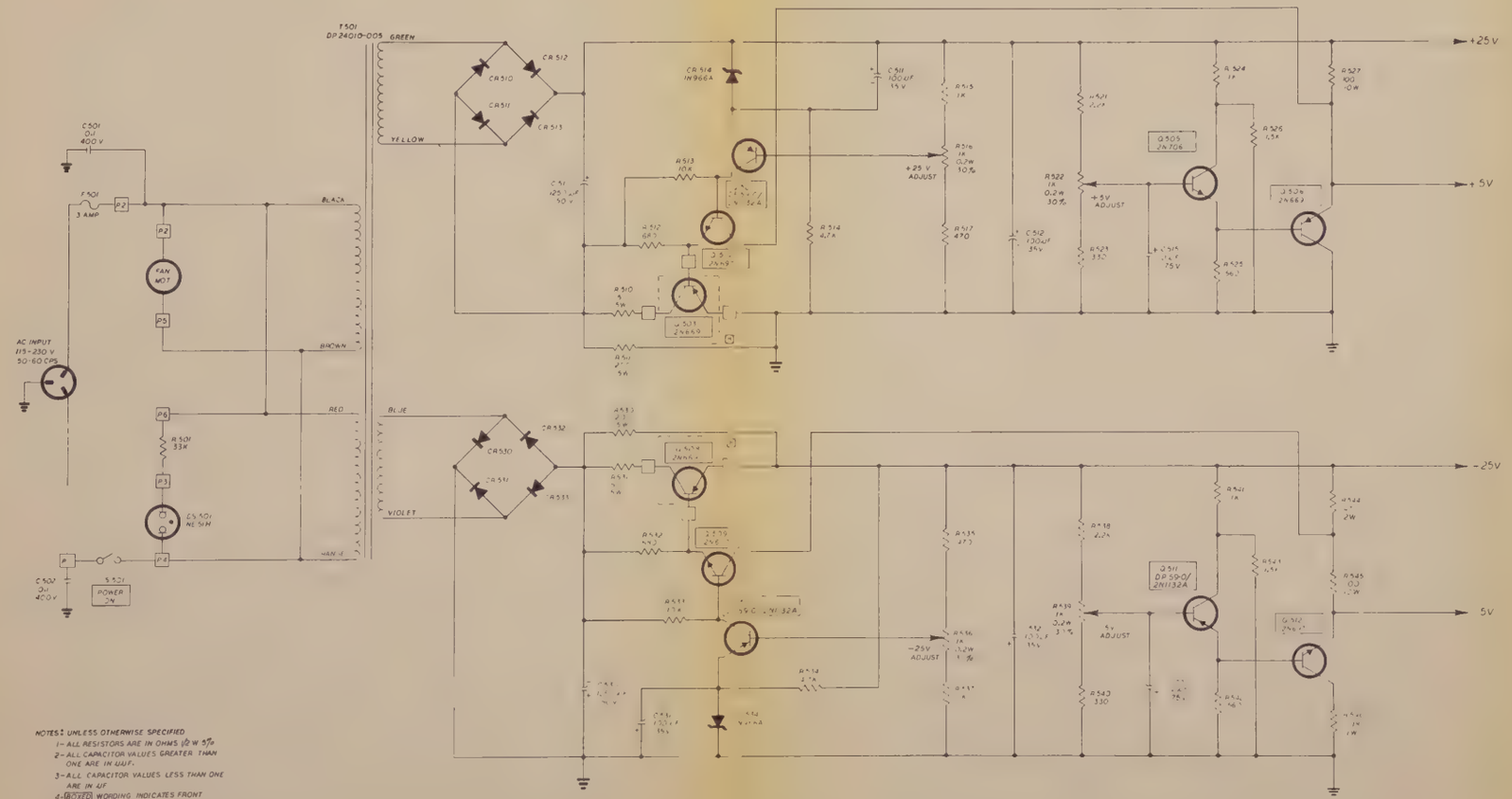
REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
CR304		Same as CR301					
CR305		Same as CR301					
CR306		Same as CR301					
CR307 thru CR319		Not Used					
CR320 thru CR325		Same as CR301					
CR326 thru CR329		Not Used					
CR330	1	Zener, 10v, 1w, 5%	12154-022	37942	2Z10B		
CR331		Same as CR301					
CR332 thru CR349		Not Used					
CR350 thru CR354		Same as CR301					
CR355 thru CR369		Not Used					
CR370 thru CR374		Same as CR301					
CR375	5	Rect., Silicon, Axial Leads	22194-000	Computer Prod. Co.	DP19-0		
CR376 thru CR379		Same as CR375					
CR380		Same as CR301					
CR381		Same as CR301					
CR382		Same as CR301					
CR383 thru CR399		Not Used					
CR400	8	Silicon Rect.	22194-001	Computer Prod. Co.	DP19-1		
CR401		Same as CR400					
CR402		Same as CR400					
CR403		Same as CR400					
CR404	2	Zener, 15v, 1w, 5%	12154-017	37942	ZA15B		
CR405		Same as CR404					
CR406 thru CR419		Not Used					
CR420	3	Zener, 10v, 1w, 5%	12154-022		ZA10B		
CR421		Same as CR420					
CR422 thru CR439		Not Used					
CR440		Same as CR400					
CR441		Same as CR400					
CR442		Same as CR400					
CR443		Same as CR400					
CR444		Same as CR420					

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
CR445 thru CR509		Not Used					
CR510	8	Rect., Silicon	22194-001	Computer Prod. Co.	DP19-1		
CR511		Same as CR510					
CR512		Same as CR510					
CR513		Same as CR510					
CR514	2	Zener, Silicon, 16v, 500ma, 10%	12154-004	99942	1N966A		
CR515 thru CR529		Not Used					
CR530		Same as CR510					
CR531		Same as CR510					
CR532		Same as CR510					
CR533		Same as CR510					
CR534		Same as CR514					

5.6 MISCELLANEOUS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
T41	39	Pulse Xfmr, 1:1, 5%, 6μh	14165-001	90095	1W6HA		
T42		Same as T41					
T43		Same as T41					
T81		Same as T41					
T82		Same as T41					
T140		Same as T41					
T301		Same as T41					
T302		Same as T41					
T320		Same as T41					
T400	1	Isolation Xfmr	24080-000	15933	24080-000		
T501	1	Pwr. Xfmr., w/extra end bell	24010-005	15933	24010-005		
DC41	1	Delay line .13μs, 500Ω	14200-005	14831			
DC81	1	Delay line .026μs, 320Ω	14190-000	14831			
L1	1	Inductor, 10μh	14284-003				
L2	1	Inductor, 15μh	14284-000	99848	1015-15-150		
XQ11	4	Socket Tstr, 3 recept.	15100-000	91662	3303		
XQ12		Same as XQ11					
XQ13		Same as XQ11					
XQ14		Same as XQ11					
DL330	1	Delay line, .1μs, 500Ω	14200-000	14831	DDL500-0.1		
S6	1	Rotary Switch	25260-001	81716			


THIS CIRCUITRY UTILIZES FRONT END POWER SUPPLY ONLY
.13 U SEC. DELAY
SYNC DRIVER
SYNC OUTPUT AMPLIFIER
POS
SYNC OUTPUT
W4
NEG SYNC POLARITY
OSCILLATOR
W1
SCHMITT TRIGGER
W2
CLOCK DRIVER
W3
DELAY ONE-SHOT
W5
PICK-OFF AMPLIFIER
W6
WIDTH ONE-SHOT
W7
PICK-OFF AMPLIFIER
EXT TRIGGER INPUT
SINGLE PULSE
V1
EXT. GATE INPUT
.026 U SEC DELAY
PICK-OFF AMPLIFIER
AND
LEADING EDGE TRIGGER
W8
AND
TRAILING EDGE TRIGGER
W9
FLIP FLOP
Ā
A
W13
EMITTER FOLLOWER
.1 U SEC. DELAY
RESET
W14
COMPARE
W15
OUTPUT SAMPLE
W17
AND
"0" REF
W18
ONE SECOND PROTECT MULTI-VIBRATOR
LAMP DRIVER
R
OVERLOAD
CIRCUITRY WITHIN DOTTED LINES UTILIZES OUTPUT POWER SUPPLY ONLY
W11A
POS
W10
OUTPUT AMPLIFIER
W11
50 Ω ATTENUATOR
PULSE OUTPUT ZO: 50Ω
W12
NEG PULSE POLARITY
REVISIONS
LIST OF MATERIALS
BLOCK DIAGRAM – MODEL 108
DATAPULSE INC.
SIZE D
41000-024
SCALE NONE
CODE 15933
41000-024



NOTES: UNLESS OTHERWISE SPECIFIED

1- ALL RESISTORS ARE IN OHMS 1/2 W 5%
2- ALL CAPACITOR VALUES GREATER THAN ONE ARE IN UUF.
3- ALL CAPACITOR VALUES LESS THAN ONE ARE IN UF
4- BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE
5- BOXED LETTERS AND/OR NUMBERS INDICATE SPECIFIC LABELED POINTS ON CIRCUIT BOARD
6- ALL DIODES ARE DP 19-1
7- T501 IS SHOWN CONNECTED FOR 115 VAC OPERATION.
FOR 230 VAC OPERATION:
1. BREAK CONNECTION BETWEEN BLACK AND RED WIRES
2. BREAK CONNECTION BETWEEN BROWN AND ORANGE WIRES
3. CONNECT BROWN AND RED WIRES

(A) - Q503, Q508 ARE MOUNTED ON BACK PANEL

DS501	DS501	
F501	F501	
T501	T501	
S501	S501	
Q501	Q512	
CR510	CR514	
C501	C535	
	R546	
FIRST USED	LAST USED	OMITTED

REFERENCE DESIGNATIONS (501-599)

DRAWN	
CHECKED	
ENGINEER	
APPROVED	
SCALE NONE	MODEL 108

SCHEMATIC - POWER SUPPLY +5V & ±25V

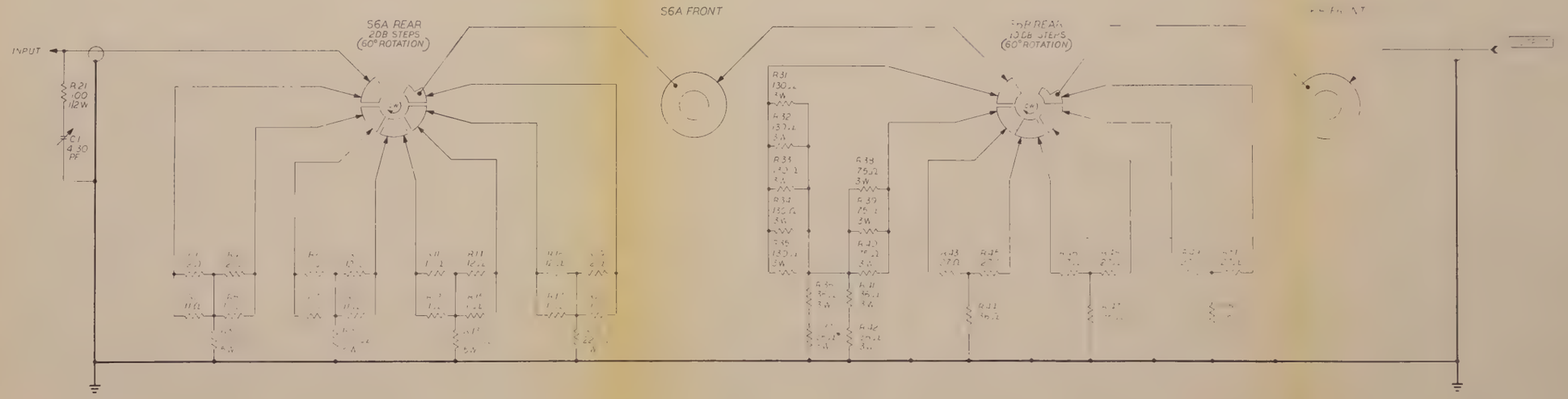
DATAPULSE INCORPORATED

40000-150

SHEET 1 OF 1

400U0-050

AMPLITUDE
VOLTS
WITH 50Ω TERMINATION



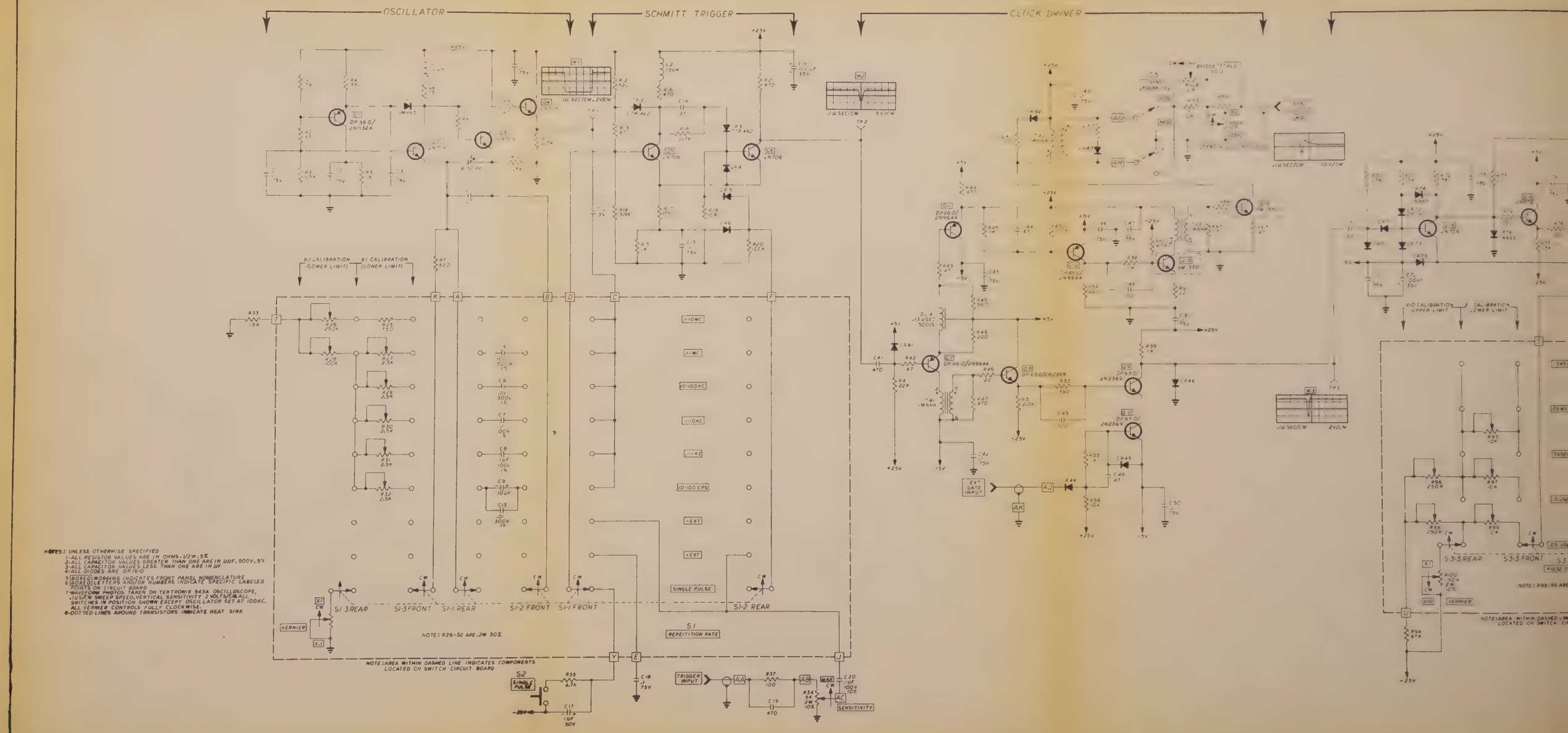
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE 2W, 5%
2. SWITCHES ARE SHOWN IN FULLY COUNTER CLOCKWISE POSITION AS VIEWED FROM CONTROL KNOB
3. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE

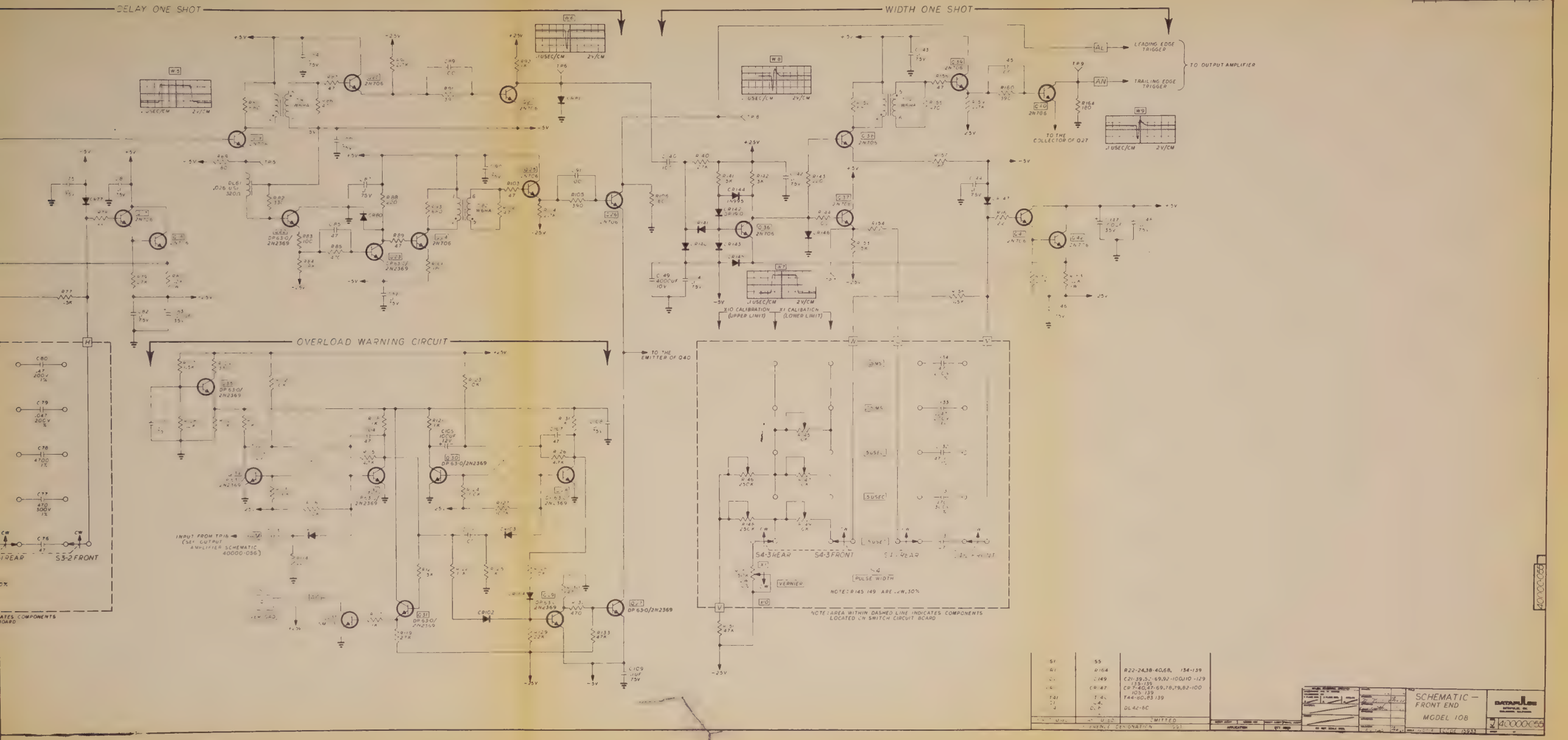
REFERENCE DESIGNATIONS		
C1 S6 R	C1 S6 R51	R20 R30 OMITTED
FIRST USED	LAST USED	

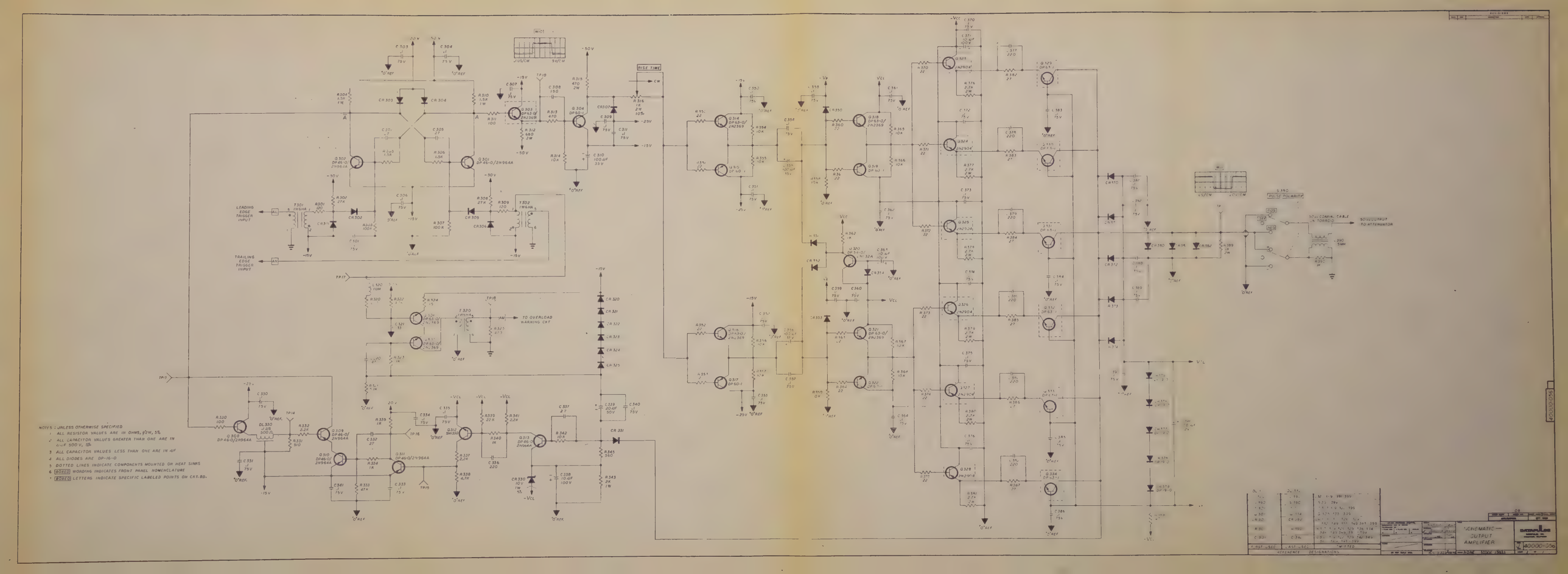
SCHEMATIC —
ATTENUATOR
50 db

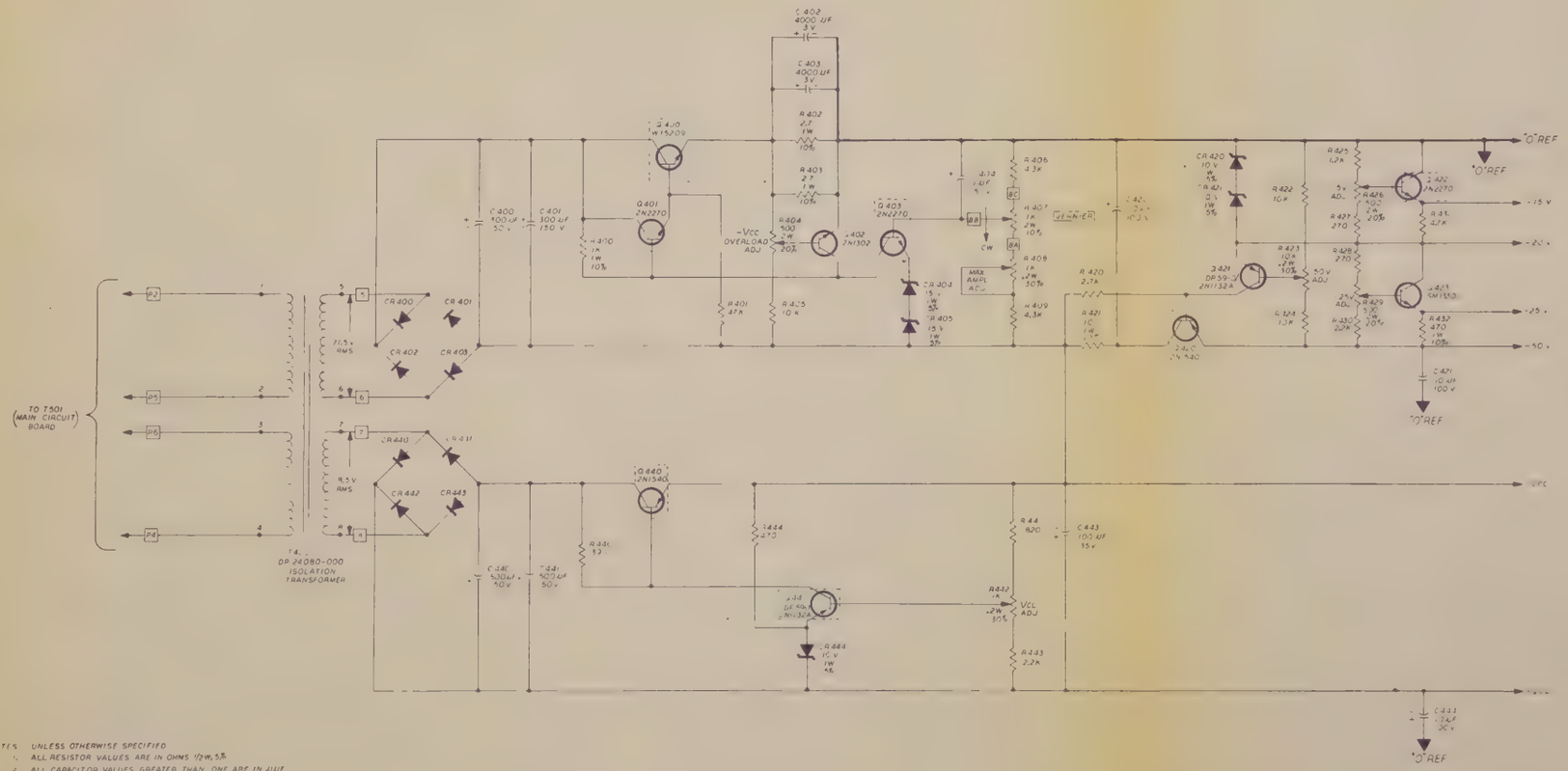
40000-053

40000-053


OSCILLATOR
SCHMITT TRIGGER
CLOCK DRIVER
X.1 CALIBRATION (LOWER LIMIT)
X1 CALIBRATION (LOWER LIMIT)
X10 CALIBRATION UPPER LIMIT
CALIBRATION LOWER LIMIT
1-10NC
1-1NC
10-100KC
1-10KC
1-1KC
10-100 CPS
-EXT
+EXT
SINGLE PULSE
S1 REPETITION RATE
S1 3REAR
S1-3FRONT
S1-1 REAR
S1-2 FRONT
S1-1 FRONT
S1-2 REAR
S3-3 REAR
S3-3 FRONT
VERNIER
SINGLE PULSE
TRIGGER INPUT
SENSITIVITY
EXT GATE INPUT
NOTE: R26-32 ARE .2W 30%
NOTE: AREA WITHIN DASHED LINE INDICATES COMPONENTS LOCATED ON SWITCH CIRCUIT BOARD
NOTES: UNLESS OTHERWISE SPECIFIED
1-ALL RESISTOR VALUES ARE IN OHMS, 1/2W, 5%
2-ALL CAPACITOR VALUES GREATER THAN ONE ARE IN UUF, 500V, 5%
3-ALL CAPACITOR VALUES LESS THAN ONE ARE IN UF
4-ALL DIODES ARE DP16-0
5 [BOXED] WORDING INDICATES FRONT PANEL NOMENCLATURE
6 [BOXED] LETTERS AND/OR NUMBERS INDICATE SPECIFIC LABELED POINTS ON CIRCUIT BOARD
7-WAVEFORM PHOTOS TAKEN ON TEKTRONIX 343A OSCILLOSCOPE, .1US/CM SWEEP SPEED, VERTICAL SENSITIVITY 2 VOLTS/CM. ALL SWITCHES IN POSITION SHOWN EXCEPT OSCILLATOR SET AT 100KC. ALL VERNIER CONTROLS FULLY CLOCKWISE.
8-DOTTED LINES AROUND TRANSISTORS INDICATE HEAT SINK


DELAY ONE SHOT
WIDTH ONE SHOT
OVERLOAD WARNING CIRCUIT
LEADING EDGE TRIGGER
TRAILING EDGE TRIGGER
TO OUTPUT AMPLIFIER
TO THE COLLECTOR OF Q27
TO THE EMITTER OF Q40
INPUT FROM TP16 (SEE OUTPUT AMPLIFIER SCHEMATIC 40000-056)
X10 CALIBRATION (UPPER LIMIT)
X1 CALIBRATION (LOWER LIMIT)
S4-3 REAR
S4-3 FRONT
S5-1 REAR
S5-2 FRONT
VERNIER
PULSE WIDTH
NOTE: R145 149 ARE ±2%, 50%
NOTE: AREA WITHIN DASHED LINE INDICATES COMPONENTS LOCATED ON SWITCH CIRCUIT BOARD
S1 S5
R164
C149
CR147
T31
L4
D4
R22-24,38-40,68, 134-139
C21-39,51-69,92-100,110-129 135-139
CR7-40,47-69,78,79,82-100 105 139
T44-60,83 139
DL42-60
SCHEMATIC — FRONT END MODEL 108
40000-055


NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS, 1/2W, 5%
2. ALL CAPACITOR VALUES GREATER THAN ONE ARE IN μF 500 V, 5%
3. ALL CAPACITOR VALUES LESS THAN ONE ARE IN μF
4. ALL DIODES ARE DP-16-0
5. DOTTED LINES INDICATE COMPONENTS MOUNTED ON HEAT SINKS
6. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE
* BOXED LETTERS INDICATE SPECIFIC LABELLED POINTS ON CRT BD.
LEADING EDGE TRIGGER INPUT
TRAILING EDGE TRIGGER INPUT
RISE TIME
TO OVERLOAD WARNING CKT
50 VOLT INPUT TO ATTENUATOR
50 OHM COAXIAL CABLE (TOWARD)
SCHEMATIC — OUTPUT AMPLIFIER
TEKTRONIX
80001-556



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS 1/2W, 5%
2. ALL CAPACITOR VALUES GREATER THAN ONE ARE IN UUF
3. ALL CAPACITOR VALUES LESS THAN ONE ARE IN UF
4. ALL DIODES ARE DP-191
5. DOTTED LINES INDICATE COMPONENTS MOUNTED ON HEAT SINKS
6. [BOXED] WORDING INDICATES FRONT PANEL NOMENCLATURE
7. [BOXED] NUMBERS AND LETTERS INDICATE SPECIFIC LABELED POINTS ON CKT. BOARD

* 400	* 600	
* 430	* 440	Q 404 - 419, 424 - 439
* 500	* 444	C 403 - 419, 422 - 439
* 500	* 444	R 370 - 419, 433 - 439
* 400	444	CR 416 - 419, 422 - 439
FIRST USED	LAST USED	OMITTED

REFERENCE DESIGNATIONS

SCHEMATIC — POWER SUPPLY OUTPUT AMPLIFIER

DATAPULSE

40000-050

APPENDIX A

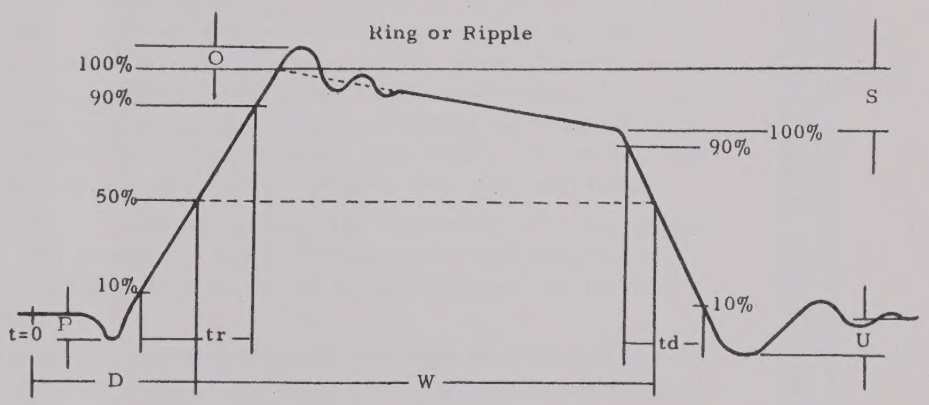
ABBREVIATIONS • SYMBOLS • TERMINOLOGY

A pulse is defined as a momentary, sharp change in current, voltage or other quantity that is normally constant. Simply stated, a pulse may be considered as a transient change in dc voltage such as that caused when a switch is opened and closed. Since modern systems react at speeds nearly comparable to switching times, the exact characteristics of pulses and the performance to be expected of pulse generators is very important.

A pulse is characterized by a rise and a decay and has a finite duration. The definitions of these and other pulse characteristics are somewhat arbitrary but are generally accepted as indicated in Figure 1. In Figure 1, "tr" is the rise or leading edge time. This is the time between the 10% and 90% amplitude points on the leading edge of either positive or negative pulses. Decay time, "t_d", often referred to as "fall time" is the time between the 90% and 10% amplitude points on the trailing edge of both positive and negative pulses. "W" is the pulse width or duration and is measured from the 50% point on the leading edge to the corresponding point on the trailing edge. "D" is the delay from a reference and is measured from the 50% point on the leading edge of the sync to the 50% point on the leading edge of the output pulse. "S" is the top slope and is usually expressed in percent of leading edge 100% amplitude, as is the overshoot "O". Undershoot, "U", is a damped oscillation occurring at the completion of decay time.

Several additional terms frequently encountered include: "Jitter"-- a variation in time of any pulse parameter from cycle to cycle; "Pulse Width Duty Cycle"-- the percentage ratio of the pulse duration to the period of the pulse signals; "Resolution"--- the smallest, definable increment of a given figure.

D=Delay
W=Pulse Width
tr=Rise Time
O=Overshoot
S=Top Slope
td=Decay Time
U=Undershoot
P=Preshoot



Capacitive Loads

Required source impedance (Zo) for driving a circuit is given by the equation

$$Zo = \frac{tr}{2.2C}$$

where tr is the rise time required and C is the input capacity of the circuit driven. From this it is readily apparent that the input admittance of an oscilloscope probe precludes observation of high impedance phenomenon without alterations in both amplitude and rise time.

Oscilloscope Response

In the area of oscilloscope observation, one must note the effect of the vertical amplifier response of the oscilloscope upon rise time observation.

$$t_{obs} = \sqrt{t_{in}^2 + t_{scope}^2}$$

gives the relationship of observed rise time, scope rise time, and actual rise time. This equation may be written:

$$t_{in} = \sqrt{t_{obs}^2 - t_{scope}^2}$$

For example, given vertical amplifier response of 15 nanoseconds and a rise time is observed to be 18 nanoseconds, then the actual rise time

$$t_{in} = \sqrt{18^2 - 15^2}$$

or approximately 10 nanoseconds while an observed 16 nanoseconds would be an actual 5 nanoseconds (twice as fast). It is then apparent that for observations of phenomenon in the region of 10 nanoseconds and less, resolution of most oscilloscopes is not sufficient for actual comparison. Two solutions present themselves. First is the use of a traveling wave oscilloscope or if the phenomena is reoccurring, a sampling technique. The second is a method of displaying the desired signal directly upon the deflection plates of the oscilloscope. Most manufacturers such as Tektronix, Dumont, and Hewlett-Packard have this feature available.

WARRANTY

Datapulse Incorporated warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective.

Instruments returned under this Warranty will not be accepted at the Datapulse plant without prior authorization by a Datapulse representative or by the service manager of Datapulse Incorporated.

Datapulse Incorporated reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Datapulse Incorporated and Datapulse Incorporated neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Datapulse Incorporated instruments.